AERONAUTICAL ENGINEERING REVIEW

DECEMBER 1949

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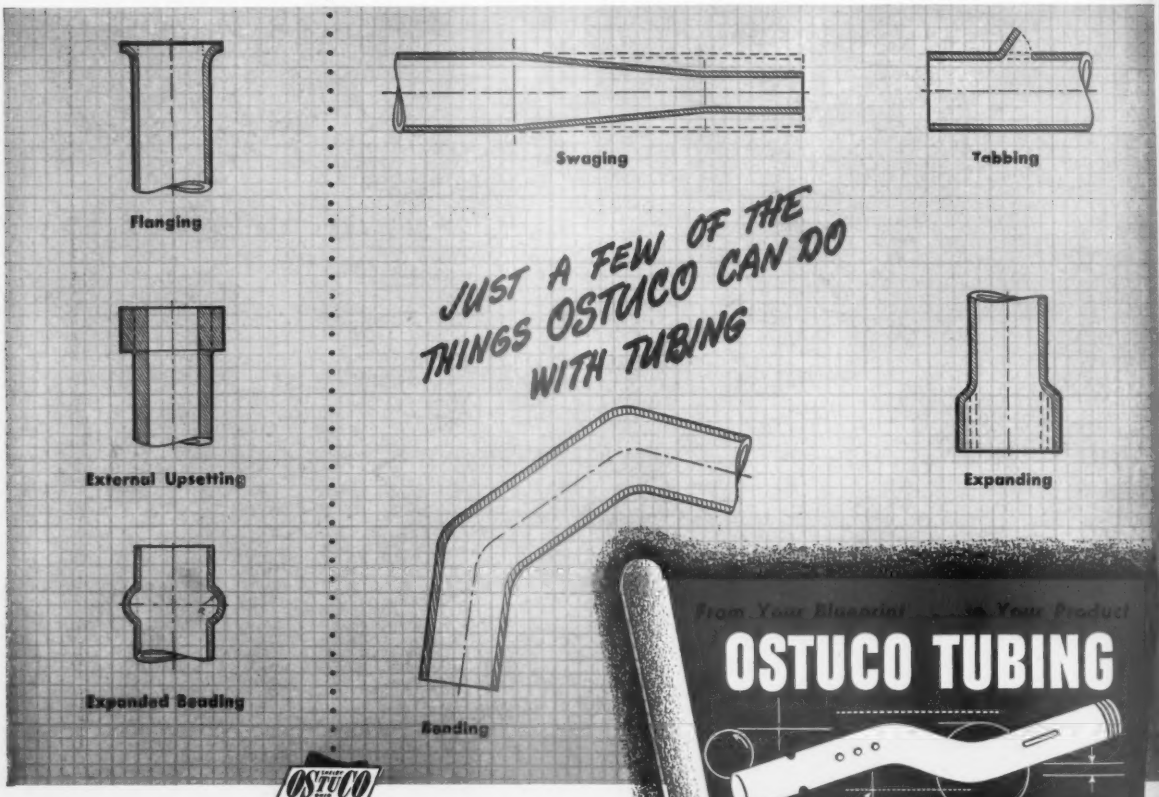

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Cover—First official flight—Avro Jetliner
(See page 22).

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I.A.S. News

A Record of People and Events of Interest to Institute Members

Walter Lippmann to Speak at Honors Night Dinner

Noted Columnist, Now Abroad, Will Report Latest Observations on Significant Events in Europe and Far East and Their Relation to World Peace at Hotel Astor on January 23; Technical Sessions Tentatively Set.

THE ANNUAL HONORS NIGHT DINNER of the Institute of the Aeronautical Sciences, to be held Monday, January 23, will have as its guest of honor and principal speaker Walter Lippmann, noted author of *Today and Tomorrow*, a newspaper column carried in nearly all cities of this country and widely published in South America, Canada and Australia.

William A. M. Burden, I.A.S. President for 1949, who, at the Dinner, will relinquish his office to his successor, as yet unnamed, will introduce Mr. Lippmann in one of his final official acts.

▸ **Political Significance**—Lippmann, whose penetrating apprehension and lucid language have made him a top commentator on world and national political and economic events, is now traveling in the Far East on a tour that has taken him through Europe's economic and social ferment. In his talk it is expected that he will relate the political significance of air power to events in Europe and give an up-to-the-minute analysis of happenings in China.

Lippmann's varied career has included service as Assistant to the Secretary of War, and Captain, Military Intelligence, U.S. Army, thirty years ago. Later, he served on the staff that assembled material for the American delegation to the Versailles Peace Conference after World War I.

From 1921 to 1931, he was editor of the old *New York World*, and during this time he made that paper's editorial page one of the most famous in the U.S. Since 1931, he has been a columnist for the *New York Herald Tribune*. His opinions are among the most often discussed and the most often quoted statements of any columnist.

▸ **Technical Program**—As in the past two years, Technical Sessions begin on Monday morning. Tentative plans are for sessions on Rotating Wing Aircraft and on Instruments in the morning and one session on Aerodynamics in the afternoon, which will be followed by the Dinner in the evening.

On Tuesday morning and afternoon, the sessions on Aerodynamics will be continued, and in the evening, for the first time, a session on Aeroelasticity will be held, according to tentative plans now being made.

On Wednesday, the Program Committee plans to start the day with a morning session on Structures. A Design session will be held in the afternoon, and in the evening, one on Air Transport Safety.

On Thursday, there will be a half-day session. It is hoped to obtain a top aeronautical turbine authority from Great Britain to present the British jet-aircraft picture and to have this lecture followed by discussion from American experts. In the afternoon a trip to one of the nearby aircraft plants is being planned.

A complete program containing schedules, titles of papers, and names of authors and principal speakers will be forwarded to the entire membership during December.

Analyzer: *Honors Night guest-of-honor, Walter Lippmann, will give his views on recent world events at the I.A.S. Annual Dinner at the Hotel Astor on January 23.*

National Meetings Calendar

Dec. 17	Wright Brothers Lecture, Washington, D.C.
Jan. 23–26, 1950	Eighteenth Annual Meeting, New York.
March 24, 1950	Flight Propulsion Meeting, Cleveland

For details see page 23

Chief Engineer of Martin: *William B. Bergen who has been named Chief Engineer in complete charge of The Glenn L. Martin Company's engineering activities, previously was Director of the Special Weapons Department, and has been with Martin since 1937. C. C. Pearson, President, in making announcement of Bergen's promotion, also disclosed that D. Roy Shoults had resigned as Vice-President–Engineering.*

New Martin Appointment Marks Significant Trend

Appointment of William B. Bergen, Director of the Special Weapons Department of The Glenn L. Martin Company's Engineering Division, as Chief Engineer in complete charge of the company's engineering activities marks a significant trend in the 40-year old Baltimore plant.

▶ **Growing Importance**—Mr. Bergen, M.I.A.S., has been with the Martin company since his graduation from Massachusetts Institute of Technology in 1937. His appointment highlights the growing importance of such advanced fields as rocketry, pilotless aircraft and missiles, and advanced electronics and electromechanisms as significant factors in the aircraft industry.

All these responsibilities are included in the Special Weapons Department that has been under Mr. Bergen's immediate direction.

National recognition was given to his engineering achievements in 1943 when he received the Lawrence Sperry Award of the I.A.S. for his "theoretical and experimental investigations of dynamic loads on aircraft."

▶ **Initiated Pilotless Planes**—In November, 1945, Mr. Bergen initiated pilotless aircraft development for the Martin company and was made Chief of the newly formed Pilotless Aircraft Section. In 1948, he was promoted to Director of the new Special Weapons Department comprising the electronics, electromechanical, pilotless-aircraft, and fire-control sections.

Under his direction, Martin engineers have designed and tested successfully the Gorgon IV and the Viking, which are claimed to be the world's first ram-jet-powered air vehicle to achieve free flight and the first American high-altitude sounding rocket, respectively.

In addition, Mr. Bergen has been supervising a varied and important electronic fire-control development program, and other special weapons projects of a highly classified nature.

Navy's D.C.S. Award Presented To Fisher For Tunnel Work

The first Distinguished Civilian Service Award to be presented by the Secretary of the Navy at the Naval Ordnance Laboratory since World War II was given to Lyman C. Fisher, M.I.A.S., early last October.

▶ **Extraordinary Ability**—Associate Chief of the Laboratory's Mechanics Research Division, Fisher received the award for "extraordinary engineering ability, guidance, leadership, and executive competency" pertinent to the "reconstruction, renovation, and improvement of the Kochel Supersonic Wind Tunnels" now in operation at White Oak, Silver Springs, Md.

A member of the U.S. Technical Mission that went to Germany in 1945, Mr. Fisher was appointed Project Engineer for the reconstruction of the tunnels on his return to the U.S. Placed at White Oak by decision of the Joints Chiefs of Staff, the tunnels were put in operation officially last June. Air speeds five times the speed of sound have been attained in them—a world record for large-size tunnels.

▶ **Reconstructed Tunnels**—The tunnels were captured in Kochel, Bavaria, by American troops advancing through Germany towards the end of the war in Europe.

Mr. Fisher, who directed the dismantling of the facility and its reconstruction and modernization at White Oak, came to the Naval Ordnance Laboratory in 1941 from Murray Corporation of America. He was graduated from the University of Michigan in 1932.

The tunnels are the same used by German scientists in development of V-2 rockets at Peenemünde, where the facilities originally were located. Bombed by the R.A.F. and Eighth Air Force, the Peenemünde wind tunnels and research center were removed to Kochel, where they were discovered intact by U.S. troops.

Navy Honors Fisher: *Lyman C. Fisher was presented the Distinguished Civilian Service Award by the Navy Secretary for his work on the Kochel Supersonic Wind Tunnels, first presentation of the Award since end of World War II*

Airports Advisory Committee Meets in Los Angeles in January

Colonel Clarence M. Young, M.I.A.S., announced that the 12-man Airports Advisory Committee of the C.A.A. will hold its next meeting during January, 1950, in Los Angeles.

Colonel Young, who, as a committee member, represents Region 6 of the C.A.A., which embraces California, Nevada, Arizona, and Utah, said that current studies by committee members cover the physical development and expansion of the nation's airports; economic allocation of Federal Airport Act funds; coordination of airline, government, military, private, and other interests in their relationship to airport improvement programs; and coordination between airports and airport users.

First meeting of the new committee was held in Washington, D. C.

New 'Copter Patents Awarded Hiller

The U.S. Patent Office has awarded six new basic helicopter patents, covering 35 claims, to Stanley Hiller, Jr., T.M.I.A.S., President of United Helicopters, Inc., Palo Alto, Calif.

Four of the patents cover the coaxial design, and the remaining two are for jet torque control and a simple system of direct control now featured in Hiller 360 helicopters. New "Rotor-Matic" control system, as it is called, is said to have achieved basic stability in helicopters for the first time.

Institute Director on R.D.B. Aeronautics Committee

Dr. Karl T. Compton, Chairman of the Research and Development Board, announced on October 14 the appointment of I.A.S. Director S. Paul Johnston as a member of the R.D.B. Committee on Aeronautics.

The Committee has recently been reorganized under the Chairmanship of Philip B. Taylor, F.I.A.S., of Sanderson and Porter. Its military members include: Rear Admiral C. M. Bolster, U.S.N., Honorary Member, I.A.S.; Rear Admiral E. A. Cruise, U.S.N.; Major General A. R. Crawford, U.S.A.F.; Col. Marshall S. Roth, U.S.A.F., Member, I.A.S.; Col. H. M. Monroe, U.S.A.; and Lt. Col. C. B. De Gavre, U.S.A.

Other civilian members previously appointed are: Dr. Hugh L. Dryden, F.I.A.S., N.A.C.A.; Dr. C. C. Furnas, F.I.A.S., Cornell Aeronautical Laboratory; and William Littlewood, F.I.A.S., American Airlines. Mr. James D. Redding, A.F.I.A.S. and former Aviation Manager for the S.A.E., is the Committee's Executive Director.

Stevens Institute Offers Hydrodynamic Design Courses

Dr. B. K. Erdoss, M.I.A.S., has announced two new courses in hydrodynamic design of seaplanes, established under the new Department of Fluid Dynamics at the Graduate School of Stevens Institute of Technology.

Both courses, the first of which began with the fall semester at the college, are being conducted by Boris V. Korvin-Kroukovsky, F.I.A.S., Research Professor in Fluid Dynamics and former Vice-President in Charge of Engineering, Edo Corporation.

Chipmunk, Beaver Designer Resigns de Havilland Post

W. J. Jakimiuk, M.I.A.S., Chief Designer of de Havilland Aircraft (Canada) Ltd. since 1940, has resigned from his post and is now in Paris, France.

▶ **Varied Activities**—Among various activities, he was responsible for the design of the de Havilland Chipmunk trainer adopted by the Royal Air Force and several other countries; the famous Beaver single-engined transport widely used in Canada's bush country, and the DH 113 jet night fighter.

Before the war he was responsible for the design of the series of Polish P.Z.L. fighters used by the air forces of five European countries and of the twin-engined 14-passenger transport for the Polish Airlines "LOT."

Chase Avitruc Transport Completes Flight Test

The Chase Avitruc military transport completed its first trial flight at Trenton, N.J., on October 14 before a group of some 500 spectators which included Air Force and Army officers and newspaper and aviation writers. The Avitruc, designated the XC-123, was designed and built by Chase Aircraft Company, Inc., West Trenton, N.J., for the U.S. Air Force.

▶ **Transport into Combat Area**—The transportation of combat and engineer equipment for air-borne assault troops is the primary mission for which the XC-123 was designed. Other uses are the resupply by air of advance combat positions, the evacuation of wounded, and the bringing of paratroops and their equipment to jumping areas. Where difficult terrain obstructs ground transportation of equipment, supplies, or personnel, employment of the Avitruc is expected to be of advantage since its maneuverability, take-off, and landing characteristics enable it to operate over rough terrain or on short unprepared landing areas.

An entire engine change can be completed in 45 minutes through the provision of conical fittings on the mountings and quick-disconnect lines and mechanisms. Safety and fire-control features are also designed to further the Avitruc's utility as a tactical aircraft.

▶ **Performance**—Pending release of flight-test data, only estimated figures on performance have been made known. These include a cruising speed at sea level of 200 m.p.h., a maximum speed at sea level of 250 m.p.h., and a stalling speed of 75 m.p.h.

Service ceiling at normal rated power is 27,500 ft., and range with maximum cargo at optimum cruising speed at sea level is 1,350 miles.

Take-off distance over a 50-ft. obstacle (returning from mission) is 750 ft. Landing over a 50-ft. obstacle at design gross weight with deceleration devices is 1,000 ft.

The test at Trenton provided a good demonstration of how the Avitruc would perform under actual combat conditions. With a cross-wind blowing, the airplane took off in 12 sec. after a run of 600 ft. and circled the field several times. Coming in for a landing, the XC-123 made a near ground loop but came to a stop, completely undamaged, in a matter of 6 sec. after a landing run of only 300 ft. Neither Robert W. Wheatley, pilot, William F. Sauers, copilot and Chase Executive Engineer, nor any of the other men aboard were shaken up. The pilot remarked afterwards that such a landing would be considered routine on a combat mission.

▶ **Specifications**—The Chase XC-123 Avitruc is 77 ft. in length and has a wing span of 110 ft. Height, from ground to tip of vertical fin, is 32 ft. 8 in. Power is supplied by two Pratt & Whitney R-2800-83 radial engines developing 2,400 hp. at take-off.

Other data are: empty weight, 24,792 lbs.; cargo load, 21,008 lbs.; maximum gross weight, 54,000 lbs.; wing loading 37.4 lbs. per sq.ft.; and cargo-carrying volume, 3,570 cu.ft.

Potts Medal Presented To Dr. C. R. Hanna

Dr. Clinton Richards Hanna, M.I.A.S., Associate Director of Research at Westinghouse Electric Corporation, East Pittsburgh, Pa., was awarded a Howard N. Potts Medal at the annual Medal Day ceremonies of the Franklin Institute for his invention of the Tank Gun Stabilizer.

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Wright Brothers' Watches Exhibited in Aeronautical Archives

Four watches closely associated with the historic flights of Orville and Wilbur Wright have been put on exhibition in the Aeronautical Museum at I.A.S. Headquarters in New York City. The watches are part of a collection of awards, mementoes, clippings, and pictures received from the Estate of Orville Wright, who died on January 30, 1948 in Dayton, Ohio, at the age of 76.

▸ **Timed First Flights**—One of the timepieces (*extreme left*) is a nickel-plated stop watch that was used by both Orville and Wilbur Wright at Kitty Hawk from 1900 to 1903. With this watch, the two brothers timed the flights of their experimental gliders and, on December 17, 1903, the first powered flight. They also used it to clock the three flights that were made later on the same day. This stop watch, purchased in 1892, has a 60-sec. dial and registers to 10 min.

The gold hunting-case pocket watch (*center left*) was carried by Orville Wright on the first and third flights of December 17. Wilbur carried the silver hunting-case watch (*center right*) on the second and fourth flights.

The open-faced nickel-plated pocket watch (*extreme right*) belonged to Orville and was carried by him in 1908 during the demonstration flights for the U.S. Army at Fort Myer, Va.

▸ **The Wright Bequest**—The collection deposited in the Aeronautical Archives by Orville Wright's Estate includes the Daniel Guggenheim Medal awarded to Wilbur Wright in 1921, the Langley Medal awarded to both brothers in 1909, the bronze Wright Brothers Medal of the S.A.E., the Collier Trophy Award, the Washington Award, and the N.A.M. Award. Eleven scrapbooks of clippings, 28 early catalogs, and 18 framed pictures were also received. A unique item in the collection is a bladed aluminum vane given to the Wright brothers in 1906 by Patrick Alexander. This vane was made at the Institut de Aérodynamique in Kuchino, Russia, for an investigation into the effects of various air pressures on the rotation of symmetric plates. This device is described in Volume 1 of the Kuchino *Bulletin* (1906).

Gifts to the Institute Collections

Complete files of *Science Abstracts, Sections A and B, Physics and Electrical Engineering*, were received from Ward F. Davidson. Over 250 N.A.C.A. publications were donated by Sherman M. Fairchild. Over 150 current aeronautical periodicals were given by W. A. M. Burden. Twenty theoretical aerodynamic reports were received from the Douglas Aircraft Company, Inc., through the courtesy of E. F. Burton. Eight of its translations were sent by the Australian Aeronautical Research Laboratory at Melbourne through the courtesy of L. P. Coombes. Copies of early textbooks by Henry Woodhouse, *Jane's All the World's Aircraft* for 1919, and a collection of periodical clippings of that period were received from Kenneth Shaw Safe of Newport, R.I., through the courtesy of Captain John Jay Ide. Clippings, programs, and other material on the All Woman Air Show, 1949, were given by Miss Gloria Heath. Reports of the Cornell Aeronautical Laboratory were sent through the courtesy of Miss Elma T. Evans. Additional gifts were received from Airborne Instruments Laboratory, Inc.; American Institute for Research, Inc., through the courtesy of Elmer D. West; British Joint Services Mission; Canadian National Research Council; Carbide and Carbon Chemicals Corporation; Johns Hopkins University (Applied Physics Laboratory); Mrs. Bella C. Landauer; National Broadcasting Company, Inc., through the courtesy of Miss Frances Sprague; New York State Library; The Royal Society of London; Shell Oil Company, Inc.; Transcontinental and Western Air, Inc.; University of Wisconsin (Naval Research Laboratory); Walter H. Wager; U. S. Air Materiel Command; Civil Aeronautics Board; Bureau of Mines; Department of Commerce; Department of State; Military Air Transport Service; National Advisory Committee for Aeronautics; Naval Ordnance Laboratory, Silver Spring, Md.; Congressional committees on Appropriations, Armed Services, and Interstate and Foreign Commerce; and the Senate and House document rooms.

Special Gift of the Aéro Club de France

Through the generosity of the members of the Aéro Club de France and the courtesy of its president, M. Jaques Allez, and its Honorary President, Baron Amaury de la Grange, an unusual volume has been added to the collection of the I.A.S.

This is a perfect copy of François-Louis Bruel's *Histoire Aéronautique par les Monuments, Peints, Sculptés, Dessinés, et Gravés* (Paris, 1909), bound in full leather, No. 113 of 325 printed copies. The volume was part of the great exhibition of gifts from the people of France to the people of the United States which were shown on the recently completed tour of the Friendship Train.

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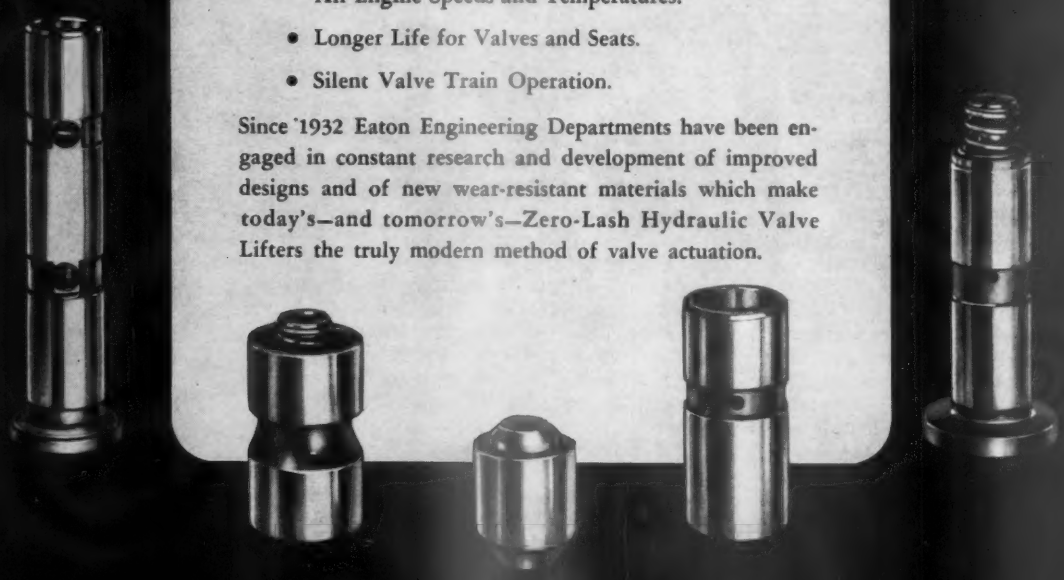

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Corporate Member News

• Portable Gas Turbine . . . **AiResearch Manufacturing Company** has developed a portable 98-lb. gas turbine producing power at an output shaft as companion to Navy-sponsored turbine previously designed to serve as a source of compressed air. Operating at speeds up to 40,000 r.p.m., new AiResearch turbine delivers 84 hp. Company estimates that in quantity production—about 1,000 a year—cost might be brought down from $20,000–$30,000 for five to ten units to between $3,000 and $4,000. . . Company was given an Air Force contract on August 3, totaling $1,066,675 for air-cycle air conditioners, heaters, tools, test equipment, engineering data and design, calculated performance data, detail design, and motor and engineering drawings.

• American Nets a Profit . . . **American Airlines System** reported a net profit of $5,935,000, after taxes, for the 9 months ended September 30. This compares with a $3,416,000 loss for the comparable 1948 period. Profit for the third quarter of 1949 was $2,399,000, as compared with $682,000 in 1948. Cost of operation for first nine months of 1949 was 46 cents per revenue ton-mile against 55 cents for the 1948 period. A considerable part of this decreased cost results from use of more modern and efficient equipment.

• Helicopter Spares . . . Air Force ordered spare parts for YH-13, H-13, and H-13B helciopters from **Bell Aircraft Corporation** last July 25. Contract totaled $410,431.

• Engine Parts Ordered . . . Fuel injection systems and spare parts for each, carburetors, and master controls were ordered in a contract let to **Bendix Products Division,** Bendix Aviation Corporation, by the Air Force last July 28–29, totaling $3,254,185.

• Closes N.Y. Office . . . **Boeing Airplane Company** closed its New York City offices, Public Relations and Sales Engineering, October 31.

• B-36 Spare Parts Order . . . Miscellaneous spare parts for B-36 bombers were ordered last July in a $200,000 contract negotiated with **Consolidated Vultee Aircraft Corporation** by the Air Force.

• Propeller Orders . . . During July and August, **Curtiss-Wright's Propeller Division** received several negotiated contracts from the Air Force, totaling $1,906,150, for modification of 972 blades and 405 hubs for B-86 aircraft; for propeller assemblies for nine YC-122 planes, less blades and control parts; and for spare blades, controls, and spare parts, and installation and spare propeller assemblies for 54 C-124A planes.

• **General Electric Company's Aircraft Gas Turbine Division** received a $10,000,000 contract from the Air Force last August 18.

• To Increase Jet Fuel Storage . . . **Grumman Aircraft Engineering Corporation** plans to increase its fuel storage and distributing equipment more than eight times in the event of M-Day orders, it was stated by Franklin T. Kurt, Director of Mobilization of Grumman. He also emphasized the need for stockpiling raw materials and special substances used in plane production when he pointed out that even now production of planes was affected by certain scarcities.

• Adds to Field Sales Staff . . . **Minneapolis-Honeywell Regulator Company's** new Belfield Valve Division is adding to its field sales staff in a new and expanded sales and manufacturing program. Company says this program will cover entire country and its efforts will be directed to all types of manufacturing and processing industries.

• F-89A Facilities . . . **Northrop Aircraft, Inc.,** negotiated a contract with the Air Force on August 23 for facilities to produce the F-89A. Contract totals $1,350,000.

• Northwest Airlines Expansion . . . Two expansion projects totaling $1,500,000 have been undertaken by **Northwest Airlines, Inc.,** to facilitate operation of its new Boeing Stratocruiser fleet. One at Minneapolis-St. Paul is to cost more than $1,000,000, while another at Seattle-Tacoma will cost $500,000. Three steel hangars are being erected at the southwest corner of Wold-Chamberlain Field, Twin Cities airport, as a service base for maintenance and storage of Stratocruisers, two of them to be completed by year-end and the third by March, 1950. The large hangar, 200 by 175 ft., will accommodate two Boeings or five Martin 2-0-2 transports at same time; two smaller hangars, each 180 by 175 ft., will take one Boeing and two Martins, or four Martin 2-0-2 aircraft at same time. Project at Seattle-Tacoma includes 72,000 sq.ft. of concrete apron with servicing facilities, and an 85-ft. extension to the side of the present hangar. Hangar work is to start next spring, whereas the apron project is underway. . . . Starting last November 5, Northwest Airlines, Inc., began Stratocruiser service from Seattle to Honolulu, reducing previous scheduled time on the transpacific route by almost 4 hours. Three weekly flights are being made with Northwest's domestic Stratocruiser and Martin 2-0-2 schedules arranged to coincide with Seattle-Honolulu arrivals and departures. Total flight time from New York to Honolulu is 20 hours, company said.

• New Hose and Pipe Chart . . . **The Parker Appliance Company** has prepared a new chart identifying and illustrating 266 types of AN, AC810, AC811, AC-type hose and pipe and N.A.F. series fittings. Sizes, materials, and emergency interchangeability data are supplied on the chart. Address: 17325 Euclid Ave., Cleveland, Ohio.

• Jetliner for $700,000 . . . **A. V. Roe Canada Limited** is ready to take orders for its new Jetliner for deliveries in second half of 1951. Company officials estimated the price for the jet transport would be approximately $700,000. The jetliner is designed specifically for short-range operations between large cities in Canada and the U.S.

• New Orders for Afterburners . . . Receipt of new orders for afterburners and jet-engine parts was reported by **Solar Aircraft Company** to total $2,100,000. Production will be divided between company's San Diego and Des Moines plants.

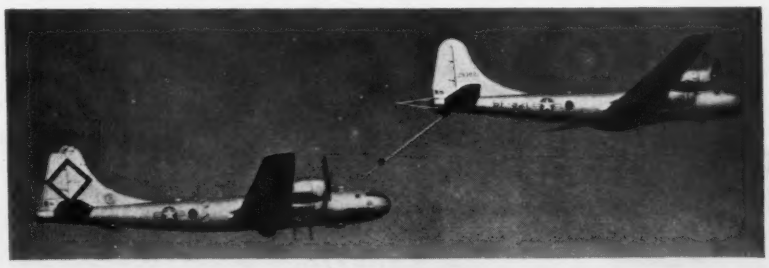
I.A.S. Newslines

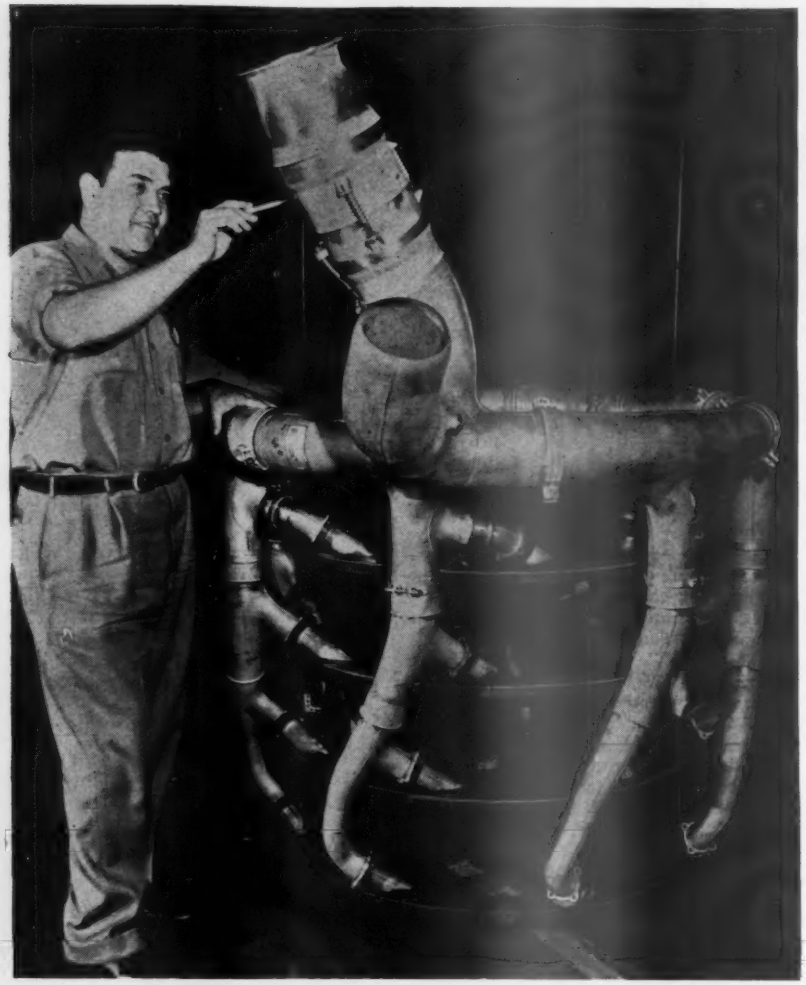
▶ BuAer Representative . . . **Commander Lester S. Chambers,** U.S.N., A.F.I.A.S., is Technical Assistant, Bureau of Aeronautics General Representative, Central District, Wright-Patterson Air Force Base, Dayton, Ohio. He was formerly Head, Aerodynamics Laboratory, David Taylor Model Basin, Navy Department, Washington 7, D.C.

▶ **Dr. Walter Georgii,** F.I.A.S., is with the Ministerio de Aeronáutica, Buenos Aires. Address is Colegiales, Zapiola 969-IA, Buenos Aires, Argentina.

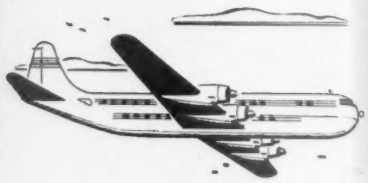
BOEING "FLYING BOOM" TRANSFERS FUEL UNDER PRESSURE

Using a telescoping pipe, the new Boeing in-flight refueling system developed for the Air Force transfers fuel under pressure from a tanker B-29 to a B-50. An improvement over the flexible-hose method used when the Lucky Lady II flew nonstop round the world last February, the "Flying Boom" consists of a telescoping metal tube equipped with small V-shape control surfaces (located at two thirds of its length), extending from rear underside of the tanker aircraft. Bomber receiving fuel has special fueling socket just forward of top gun turret in the nose section. Technician seated in tail of tanker "flies" the boom by operating the "Ruddevator" controls that govern movements of the boom either up or down or to either side. U.S. Air Force also is experimenting with aerial refueling system designed to enable fighter planes to be refueled three at a time from one tanker.





Enduro-THRIFTY METAL OF 10,000 USES



STAINLESS STEEL EXHAUST SYSTEM for the new Giant of the Airways—4-engine, double-deck, 100 passenger C-97 Stratocruiser. Luxury air travel or military air power . . . both call for metals with high heat-resistance and great strength-to-weight ratio. ENDURO Stainless Steel fills this bill and many others in the aeronautical field—in ailerons, firewalls, stabilizers, fuel tanks, valves and valve seats, control surfaces, ignition cables, drive shafts and instrument parts . . . to mention but a few.

"OPERATION INFERNO"... calls for Stainless Steel

High heat-resistance and high strength at elevated temperatures, called for in air power units, are characteristic of ENDURO Stainless Steel. But ENDURO should not be dismissed as that and nothing more.

This metal is one of the most versatile at the command of the aircraft designer. It possesses as well: high resistance to oxidization and corrosion—high tensile, impact and creep strength. In its austenitic analyses it is non-magnetic—a factor of great importance in instrument design and manufacture.

ENDURO also possesses good machining qualities—welds readily, draws and stamps well.

While dependability is more the concern of the aeronautical designer than cost, ENDURO by its very dependability and its many other characteristics is also the *economical* metal.

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▶ Air Transport of 1965? . . . **H. R. Harris,** F.I.A.S., Vice-President & General Manager, American Overseas Airlines, at recent S.A.E. meeting, said that the "Air Transport of 1955" will also have to be the "Air Transport of 1965," because the airline operator buys equipment for 10-years' use. "What will the public be willing to pay money for in 1965?" he asked. A few hints: "Can we build airplanes where floor doesn't vibrate, trays don't vibrate, bathroom doesn't vibrate?" Also, couldn't windows be 4 times larger?

▶ Named to RDB Committee . . . **William Littlewood,** F.I.A.S., Vice-President–Engineering, American Airlines System, has been named a member of the Committee on Aeronautics, Research & Development Board.

▶ Government Appointment . . . **Professor Maurice Roy,** A.F.I.A.S., has been appointed by the French government as General Director of the Office National d'Études et de Recherches Aéronautiques (O.N.E.R.A.). Previously he had been with the École Polytechnique, Paris. Address is 86, avenue Niel, Paris (XVII).

▶ Resigns Martin Post . . . C. C. Pearson, President of The Glenn L. Martin Company, announced that **D. Roy Shoults,** A.F.I.A.S., resigned October 10 as Vice-President–Engineering.

▶ RDB Committee Chairman . . . New Chairman of the Committee on Aeronautics is **Philip B. Taylor,** F.I.A.S., Partner, Sanderson & Porter, engineering consulting firm in New York.

Necrology

James Maurice Shoemaker

James M. Shoemaker, an I.A.S. Fellow and Chance Vought Aircraft's Chief Engineer since 1943, died September 28, in Dallas, Texas, after a lengthy illness.

The veteran aircraft engineer, who would have been 48 years old on November 11, first joined Pratt & Whitney Aircraft in 1928, the year before United Aircraft Corporation, now the parent company of Pratt & Whitney, was founded. In 1929, Shoemaker helped form the Engineers Aircraft Company of Stamford, Conn. From 1928 to 1930, he was responsible, to a great extent, for two experimental airplane designs—the Skyways Amphibian and a two-place monoplane built by Engineers Aircraft.

For a year, beginning in 1930, Shoemaker was a lecturer in aeronautical engineering at the University of Southern California. He then rejoined the National Advisory Committee on Aeronautics, where he had done wind-tunnel work shortly after his graduation from Purdue University in 1925. He received a Bachelor of Science degree in Mechanical Engineering from Purdue and, in 1928, a Master of Science in Aeronautical Engineering from the Massachusetts Institute of Technology. While he was at the N.A.C.A., he developed the techniques of the "complete test" of seaplane hulls and a method of applying results to take-off calculations.

He came to Chance Vought in August, 1934, as Project Engineer of Power Plants and 7 years later became Chief Project Engineer, a position he held until 6 years ago, when he was made Chief Engineer.

In addition to being an I.A.S. Fellow, he was also a vice-president, representing aircraft activity, of the Society of Automotive Engineers, and a member of Sigma Xi, Tau Beta Pi, and Pi Tau Sigma. Funeral services were held at Dallas with cremation at Restland Cemetery. He is survived by his wife, the former Iona Harrell, and two children, James and Jane.

I.A.S. Sections

Buffalo Section

Alexander Krivetsky, *Secretary*

Two speakers were heard at the September 28 meeting at which 98 members were present. Chairman George Ray presided.

▶ **News in Aviation**—Robert H. Wood, Editor of *Aviation Week*, McGraw-Hill Publishing Company, spoke on various aspects of aviation. He predicted that the atomic explosion in Russia will impress upon Congress the realization that air power must take the number one place for defense.

Also, he said, the role of the helicopter in an atomic war will be an important one since it can be employed for rescue missions in areas devastated by an atom bomb.

Mr. Wood described the background of the "break" in the news of the historic supersonic flight of the X-1, which appeared in *Aviation Week*, and the furor the story caused.

▶ **Psychological Factors**—The other speaker was Dr. Richard H. Sherwood, Medical Examiner for the Civil Aeronautics Administration at Niagara Falls. He stressed that with planes becoming faster, more attention must be paid to the psychological factors that affect the reflexes and judgment of pilots. Improved tests to show the condition of the pilot just before take-off are a necessity, he said.

Present medical and psychological examinations often are ineffective, he declared, because they do not reveal up-to-date information about the pilot. In some instances, Dr. Sherwood went on, the fliers unintentionally conceal facts about their condition, and also, doctors are frequently influenced by a reluctance to ground them out of their careers.

Chicago Section

Alfred Stott, *Secretary*

"Aircraft Fire Problems" was the topic at the September 20 meeting which was discussed by L. E. Tarbell, Chief, Reciprocating Engine Section, Power Plant Division, Civil Aeronautics Administration, Indianapolis, Ind.

▶ **10-Yr. Study of Fire**—The speaker briefly outlined the Fire Investigation and Prevention Program conducted by the C.A.A. at Indianapolis. This program has been in operation for the past ten years and consists of a very thorough study of fire-detecting devices, warning systems, and fire-fighting materials and equipment. A large portion of the work includes studying fires produced in full-scale mockups of the CW-20, B-29, and Constitution engine units. Fuel and oil fires are investigated and those caused by hydraulic fluids and other combustibles.

An elaborate full-scale bench-test section permits the testing of lines, pumps, valves, and fluids before they are installed in the operating engine unit.

A survey of liquid fire retardants for use on doped fabric has resulted in the discovery of one that will withstand a 2,000° fire for 12 sec.

Cleveland-Akron Section

William A. Fleming, *Secretary*

"Turbine Blading—Manufacture and Design" was the topic presented at the September 27 meeting by A. T. Colwell, Vice-President, Thompson Products, Inc., and Chairman of the

K+E partners

For 82 years K&E equipment and materials have been

PHOENIX WYTEFACE Non-metallic Woven Tapes

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OVER 3 TIMES LONGER WEAR. An enormous stride. A radical development. The new *non-metallic* PHOENIX WYTEFACE, as one highway engineer puts it, *"has at least three times the life of ordinary metallic tapes"*. Drastic field tests—in extremes of climate, in water and mud, over stones and rocks, under truck wheels, through brush and barbed wire—have established that fact.

Here is the reason. PHOENIX WYTEFACE is a weave of amazingly strong synthetic yarns—a scientific wartime development—completely covered and protected by a special tough plastic coating that is not affected by water, is not brittle and will not flake.

MORE ACCURATE. PHOENIX WYTEFACE will stand up to repeated soaking and drying and still maintain a dimensional stability substantially higher than that of ordinary so-called "metallic" tapes.

HIGHER DIELECTRIC CONSTANT. PHOENIX WYTEFACE Woven Tapes are entirely non-metallic—a feature that is important to Power and Utility Companies and to anyone working near high tension circuits.

EASY TO READ AND CLEAN. The clear black and red markings on the white background are easy to read. The surface is easily wiped clean.

Ask your K&E Distributor or any K&E Branch to show you the new PHOENIX WYTEFACE non-metallic Woven Tape, or write on your letterhead for a sample length to Keuffel & Esser Co., Hoboken, N. J.

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partners of the draftsman, the engineer and the scientist in shaping the modern world

NEW K&E WIDE FRAMED TRIPODS GIVE MAXIMUM STABILITY

The wide framed leg construction of these new K&E tripods and the wide, all-metal hinges joining the legs and head result in great torsional stability. This makes the instrument much steadier—less vibration—in windy weather. Legs are straight grained maple. They are easy to plant firmly, because of their long steel "Stoodite" tipped shoes and large spurs—the kind a man can get his foot on, even with boots or galoshes. The head fits all instruments with the standard 3½ inch by 8 threads. K&E Wide Framed Tripods are made in stiff leg and extension styles.

Ask your K&E Dealer or Branch to show you these tripods, or write to Keuffel & Esser Co., Hoboken, N. J.

ALBANENE* TRACING PAPER WILL NOT DETERIORATE WITH TIME

ALBANENE Tracing Paper is made from a 100% pure rag base. Its fine printing transparency is due, not to oils that leak and "bleed," but to a synthetic transparentizer that K&E developed specially for this purpose. Prints made today from drawings made on ALBANENE years ago, prove conclusively that ALBANENE does not turn brittle nor lose its transparency with time.

Ask your K&E Distributor or any K&E Branch for a sample or write to Keuffel & Esser Co., Hoboken, N. J.

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Section. The dinner that preceded the lecture was attended by 88 members. One hundred ten members were present for the talk.

Prior to the lecture, there was an inspection tour of the Thompson Products plant to give those present an opportunity to see the manufacture of the parts that would be discussed later by the speaker.

The paper covered the various manufacturing methods of turbine blades, including the good and bad points of each, and the methods most easily expanded for emergency production. Design of the blades for producibility was discussed, stressing the points that a designer should keep in mind if large production is considered.

Dayton Section

W. A. Barden, *Secretary*

Grover Loening, speaker at the September 21 meeting, pointed out that aviation transportation must not only give better service than other means of travel and overcome many hindrances but must also keep exploring new fields.

▶ **Six 'Musts'**—To compete, said Loening, the industry must provide speed as well as comfort, regularity, and reliability of operation; lower costs; and elimination of danger.

Among the hindrances to be overcome, he added, are the shortsighted men in the industry, prejudices against certain types of aircraft, clichés that become accepted as facts, price consciousness, and C.A.A. approval for every type of aircraft.

Loening believes research should be intensified on new uses for present models, a 0–200-m.p.h. private aircraft, seaplanes, and jet airliners.

Detroit Section

Joseph Rutkowski, *Secretary*

At the October 6 meeting, 26 members heard George H. Tweney, Associate Professor, Wayne University, speak on "An Introduction to Spinner Rocket Theory." Chairman L. M. Patrick presided.

▶ **Fundamental Theory**—Purpose of the paper was to present the fundamental theory and aerodynamic behavior of a projectile stabilized by spinning rapidly about its longitudinal axis, as opposed to one stabilized with the use of fins.

The nature and magnitude of the various forces and moments that act on such a projectile was presented, together with the necessary equations for their calculation.

Comments on the flight characteristics and stability of a spinner rocket were then made, which included the effects of over- and under-stability, nature of the mutations and precessions, and the resulting shape of the trajectory. Critical comparisons were made of the various methods available for analyzing the motion of a spinning projectile.

Los Angeles Section

Edwin P. Hartman, *Secretary*

On the evening of September 15, the Section held its first session of the fall season in the Institute's new Western Headquarters Building in Los Angeles.

The technical session was opened with a few remarks by Chairman Joe Barfoot. Program Chairman Robert Reedy introduced the speakers of the evening: C. B. Kesselring, Chief Pilot of Los Angeles Airways, Inc., and Howard Roberts, Aero-Thermodynamics Engineer of Douglas Aircraft Company, Inc.

▶ **Helicopter Airmail**—Mr. Kesselring's subject, "Air Mail All the Way," was presented chiefly by means of a moving picture that depicted operation of Los Angeles Airways in its pioneering venture of providing helicopter airmail service for the greater Los Angeles area. This operation has been under way for more than a year and now covers such widely dispersed cities as San Fernando, Pasadena, San Bernardino, Pomona, Santa Ana, San Pedro, and Santa Monica.

The volume of local airmail traffic has greatly increased since service was instituted, according to Mr. Kesselring, and, with it, Los Angeles Airways has expanded both organization and equipment. The company now employs 45 persons, of whom 9 are pilots who have logged more than 10,000 helicopter flight hours in airmail service. Five S-51 'copters, each equipped with 2-way radio and carrying from 700–1000 lbs. of mail, are used.

▶ **Passengers Next**—The mail service provided by the company saves many hours in the delivery of air mail to its final destination.

A natural further step, said Kesselring, is the transport of passengers from airport to downtown areas and between distant suburbs.

▶ **Earth's Atmosphere**—Mr. Robert's paper, "The Earth's Atmosphere," obviously represented considerable literary and scientific research. It was an amplification of the study made in 1944 which resulted in the famous pictorial chart, "Characteristics of the Earth's Atmosphere," which was widely distributed (*See* AERONAUTICAL ENGINEERING REVIEW, October, 1949, for complete paper).

Student Branches

Academy of Aeronautics

Election of officers was held September 12 resulting in the installing of the following new officers: Chairman, Harry W. Kirkwood; Vice-Chairman, Thomas Buckley; Secretary, George W. Gilbert; Treasurer, John F. Pereira; Corresponding Secretary, Charles J. Fletcher; and Sergeant-at-Arms, Jack Sneden.

Brown University

With Walter C. Beckwith, III, Secretary, presiding at the October 3 meeting, a color film entitled "N.A.-C.A. Research" was shown.

Obtained directly from the National Advisory Committee for Aeronautics, it depicted the research facilities of the N.A.C.A. and presented a brief survey of some of the important problems currently under investigation.

The Honorary Chairman, Dr. John R. Weske, led the discussion after the showing of the film.

Cal-Aero Technical Institute

Chairman Nick Reid, presiding at the August 30 meeting, which was attended by 130 members, introduced Jack Baumann, designer and builder of the Baumann Brigadier 250. The speaker, in addition to his executive position in the Baumann Aircraft Company, is also with North American Aviation as a Preliminary Designer in the Fuselage Group.

In an informal talk, Mr. Baumann began with the problems facing the design group. Two films of the Brigadier 250 were shown, which depicted its construction and performance.

At the September 27 meeting, attended by 130, Willis M. Hawkins, Chief Preliminary Design Engineer of Lockheed Aircraft Corporation, gave a talk on "Jet Power in Commercial Aircraft." Mr. Hawkins was introduced by the Chairman, Nick Reid.

Following the lecture, the incoming Chairman, F. Seery, and the other new officers were introduced.

Cornell University

A business meeting was held on October 11 to elect a new Secretary replacing Jean McDonald Schmidt. Nelson Kemp was elected and took office on November 1. Chairman L. E. Fogarty, presided.

In addition, Abraham Hertzberg, Research Assistant, Cornell Graduate School of Aeronautical Engineering, gave a talk on "An Experimental Investigation of Two Dimensional Non-Steady Shock-Wave Phenomena."

University of Detroit

Members at the September 26 meeting, chairmanned by Manuel A. Sanchez, heard E. A. Szczepaniak, Instructor, University of Detroit, speak on the topic, "Research Activities at the Lewis Flight Propulsion Laboratory."

University of Florida

The October 4 meeting featured a talk by Professor R. A. Thompson, Honorary Chairman of the Branch, who spoke on "The Aims and Reasons for the I.A.S." Charles E. Jordan, Chairman, presided, with 38 members attending.

A film, entitled "A Big Race for Little Wings," and produced by the Goodyear Tire & Rubber Company, Inc., was shown.

University of Kansas

New officers were elected at the September 26 meeting as follows: Honorary Chairman, Dr. William M. Simpson; Chairman, John C. Adams; Vice-Chairman, Richard A. Zlotky; Secretary-Treasurer, Virgil A. Sandborn. Paul D. Wilson, past Vice-Chairman, presided.

Massachusetts Institute of Technology

"Electronics in Propeller Development" was the topic presented by George P. Knapp, Senior Project Engineer, Curtiss-Wright Propeller Division, at the October 4 meeting.

He emphasized that the propeller is not on the way out and that there is a wide field in propeller development. The increase in propeller size has led to new techniques in manufacturing and pitch control, he said.

To guide and evaluate these new ideas, new instruments are needed, the engineer explained. The "V" strain gage that eliminates the effect of Poisson's ratio, the vibrating table, and the electronic control (to adjust the propeller and control the turbojet engine from the same source) were some of the instruments in development, according to the speaker.

Northrop Aeronautical Institute

On September 8, members made a tour through one of Lockheed Aircraft Corporation's research plants in Burbank. Laboratories visited were the electrical, chemical, hydraulics, structural testing, altitude, metallurgical, and mechanical.

The Hydraulics Department had arranged a full-scale mockup of the hydraulic system used in the Lockheed Constitution, which was operated for the benefit of the group.

In the Chemical Laboratory, tests were conducted on the relative inflammability of various hydraulic fluids.

University of Notre Dame

Chairman Walter Geudtner opened the September 29 meeting by introducing the new officers and heads of committees. He also initiated the practice of assigning freshmen to the committees to aid them in getting acquainted with the organization and the members.

Faculty Advisor William D. Drinkwater gave a short talk on "Our Purpose in Studying Aeronautical Engineering at Notre Dame."

University of Oklahoma

Two films were shown at the September 28 meeting: "Wright Builds for Air Supremacy," and "The Construction of a Light Plane." Chairman Robert L. Dickinson presided, with 35 members attending.

Secretary-Treasurer Robert T. Cambron presented a short review of the organization and functions of the I.A.S.

Rensselaer Polytechnic Institute

With 160 members and guests present, Dr. Burt L. Newkirk, Head of Vibrations Department, Department of Aeronautical Engineering, R.P.I., spoke at the September 21 meeting on "Gyroscopes." Chairman William B. Brower presided.

Dr. Newkirk explained the basic principles of all gyroscopes with the aid of a large model. In addition, he gave a short analytical description of the action. He then demonstrated some applications of the gyroscope, in-

Silicone News

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NO OIL CHANGE FOR 5 YEARS!

Dow Corning 200 Silicone Fluid Adds Years Of Life To Oil Burner Fan Motors

Photo courtesy Breese Burners, Inc.

Bearings of the BREESE DRAFBOOSTER oil furnace fan motor are lubricated with DC 200 Silicone Fluid to give years of satisfactory maintenance-free service.

Breese Burners, Inc., Santa Fe, New Mexico, manufactures the Drafbooster, one of the best fan motors available for oil-fired furnaces. Years of research and testing are incorporated into the design of this efficient unit and only high grade materials are used in its construction. Breese engineers learned, however, that in spite of well written instructions, few customers bothered to change oil each year. After two or three years' use, the oil was so badly oxidized and carbonized that the entire unit had to be replaced.

In 1944 Breese engineers obtained a sample of low viscosity DC 200 Silicone Fluid and subjected it to accelerated breakdown tests similar to those set up for testing the mineral oils Breese had been using.

M. D. Huston, Mgr. Sales Engineering for Breese, had this to say about the breakdown testing: "To our great surprise, the silicone fluid worked perfectly and showed no signs of oxidation or other deterioration. We immediately put Drafboosters containing DC 200 on lifetime field tests under the most severe operating conditions. A recent check of one unit which has been working since 1944 revealed the DC 200 Silicone Fluid is still just as good a lubricant as when it was put in. In August, 1948, we standardized on DC 200 Fluid for all our Drafboosters."

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JESSALL MULTI-CELL TAPES

1/8" *Strip-a-Tube* (actual size)

Jessall Strip-a-Tube Tapes are a bank of flexible plastic tubes lightly bonded together and easily separable into individual tubes. They are available in 1/32", 1/16", 3/32", 1/8", 3/16", 1/4" and 5/16" sizes and are designed to give a press fit over their respective size of fittings.

The Strip-a-Tube Tapes, from 1/8" up, have one tube in each bank colored for connection—identification. The entire bank may contain each tube a different color if specified.

These Tapes are used extensively in Wind Tunnel Research, Flight Instrumentation, Instrument Research, Pressure Testing, etc.

Adaptors are available for the 1/8" through 5/16" Strip-a-Tube. Cement is supplied with each 100' roll.

Sample cards will be sent upon request illustrating all the types of Jessall Multi-cell Tapes.

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cluding a ship-stabilizing type, a directional gyro, and a gyro-stabilized monorail car.

Dr. Newkirk closed his lecture-demonstration by inviting members of the audience to lift several gyro-equipped dumbbells. The resulting gyrations of the individuals ended the evening on a very amusing note.

A total of 130 members were signed up at this first meeting of the term.

University of Southern California

At the meeting of September 23, Chairman Harry Gann showed some slides that he had taken at the 1949 National Air Races and gave a running description of the planes and events.

New students, who, for the most part, had been transferred from the Santa Maria campus to the Los Angeles campus, were given an orientation talk.

Stanford University

An organizational meeting was held October 4 with Wendell P. Garton, Chairman, presiding.

Wendell Garton and Murray Dryer were retained as Chairman and Vice-Chairman, respectively, until the next election, which will be held on the first of the year. James Todd was elected Secretary, replacing the previous incumbent who had been graduated. Under a new ruling, Secretaries hereafter will be appointed by the Chairman.

University of Tulsa

At the first meeting of the semester on September 23, new officers were elected as follows: Chairman, Kenneth Murty; Vice-Chairman, John Beadling; Secretary-Treasurer, George W. Evans.

University of Wichita

The first meeting of the school year, held on October 7, featured an animated color film entitled "Gasoline's Amazing Molecules." Produced by Standard Oil Company, it gave a simplified picture of what goes into the making of gasoline.

In addition, a series of color slides of the Cleveland National Air Races was shown by Edward King. Both King and Daniel Carl, who attended the air races, made supplementary comments on the slides.

Chairman Carl presided at the meeting, which was attended by 46 members.

News of Members

H. Neil Arthur, T.M.I.A.S., is now with Ranger Aircraft Engines Division, Fairchild Engine and Airplane Corporation, as Engines & Components Tester. New address is 565 Main St., Farmingdale, N.Y., c/o Mrs. F. Zeller.

James R. Burkholder, T.M.I.A.S., is a Draftsman & Computer for Johannessen & Girand, Engineers, Tucson, Ariz. He had been Flight Test Analyst for Ryan in San Diego.

Billy J. Cook, T.M.I.A.S., is Power Connector Designer for USCO Power Equipment Corporation. He previously was Engineering Draftsman for The Glenn L. Martin Company. Address is 1225 N. 30th St., Birmingham, Ala.

H. Allan Duguid, M.I.A.S., formerly Service Engineer for Reaction Motors, is Project Engineer for The Aerotec Corporation. Address is Huntington, R.D. 1, Shelton, Conn.

Douglas E. Eastman, Jr., T.M.I.A.S., is a Junior Engineer for Boeing Airplane Company. Address is 3013 11th North, Renton 2, Wash.

John M. Eggleston, T.M.I.A.S., is a Research Engineer with the N.A.C.A. at Muroc Test Base. Address is Box 72, Muroc, Calif.

Seymour Gottlieb, M.I.A.S., Head of the Structural Flight Test Section of the Naval Air Experimental Station, Philadelphia, received his Bachelor of Laws degree from Temple University last June.

W. J. Jakimiuk, M.I.A.S., Chief Designer of de Havilland Aircraft (Canada) Ltd. since 1940, resigned last fall and is now in France. He was responsible for the Chipmunk and Beaver designs as well as the DH-113 jet night fighter. New address is 97 rue de Prony, Paris 17e, France.

Commander E. S. Keats, U.S.N., M.I.A.S., is now with Advanced Training Command, Naval Air Station, Corpus Christi, Texas.

Walter L. Koch, M.I.A.S., former Aerodynamics Engineer with North American, is now Research Physicist, Aerodynamics Department 10, Hughes Aircraft Company, Culver City, Calif.

Samuel Kraus, T.M.I.A.S., who received his Master of Aeronautical Engineering degree from Rensselaer Polytechnic Institute, is employed as an Aeronautical Research Scientist in the High Speed Research Division of the Ames Aeronautical Laboratory, N.A.C.A., at Moffett Field, Calif. Present address is 1855 Cowper St., Palo Alto, Calif.

Boris S. Kudravetz, T.M.I.A.S., has been transferred within the Aviation Gas Turbine Division of Westinghouse Electric Corporation, Philadelphia, to Jr. Engineer, 40E Design & Project Section.

Captain Virgil H. Landwehr, U.S.A.F., T.M.I.A.S., is assigned to the 91st Maintenance Squadron, Barksdale Air Force Base, La.

Lt. Colonel T. H. Lin, M.I.A.S., who was with a Technical Mission in England, is now Associate Professor, Aeronautical Engineering Department, College of Engineering, University of Detroit.

Byron Nierenberg, M.I.A.S., has been promoted to Project Engineer of Nathan Aircraft Devices, Inc. He was formerly Design Engineer.

Harold Paiss, T.M.I.A.S., formerly of Ocean Gate, N.J., now is Project Engineer, International Airways, Inc., 2027 Vine St., Hollywood, Calif.

Scott Rethorst, M.I.A.S., who had been a Consultant for the U.S.A.F., The Pentagon, Washington, D.C., now is a Student at California Institute of Technology. New address is 591 N. Daisy Ave., Pasadena, Calif.

Robert J. Schoonmaker, T.M.I.A.S., formerly Senior Test Engineer with Martin, is an Engineer at Flight Refueling, Inc. New address is P.O. Box 709, Danbury, Conn.

Ralph F. Shard, T.M.I.A.S., has been promoted by Goodyear Aircraft Corporation from Senior Draftsman to Junior Designer.

Dr. M. C. Shelesnyak, M.I.A.S., who resigned as Head, Human Ecology Branch, Office of Naval Research, Navy Department, is Director, Baltimore-Washington Office, Arctic Institute of America, a research organization. Address is Arctic Institute of America, 3506 Greenway, Baltimore 18, Md. Institute was developed in 1944 as the only scientific group in North America devoted entirely to polar research and is a private nonprofit organization.

Mrs. W. P. Stevens, Jr., T.M.I.A.S., is with Northrop Aircraft, Inc., Hawthorne, Calif. Address, 1857 Fox Hills Drive, Los Angeles 25, Calif.

Edward L. Stickel, T.M.I.A.S., has resigned from T.W.A.'s Engineering Department and is now an Engineer with the Service Group of Boeing Airplane Company at Seattle, Wash. Home address is Box 645, Redondo, Wash.

Edward James Sullivan, T.M.I.A.S., who received his M.S. from the University of Minnesota, is now with Boeing Airplane Company (Seattle) as Junior Engineer B. New address is 13831 38th Ave., S., Seattle.

RESIGNS SENSENICH POST
Leslie J. Trigg, M.I.A.S., has resigned as Chief Engineer at the Sensenich Corporation, a post he had held since November, 1945.

E. S. Thompson, M.I.A.S., Manager of Sales for General Electric's Aircraft Gas Turbine Divisions at Lynn, Mass., has been appointed to the Daniel Guggenheim Board of Award. He succeeds Fred E. Weick, F.I.A.S., of Texas A & M College as Board representative from the A.S.M.E.

Dr. Ralph H. Tripp, M.I.A.S., is in the Dynamic Test Department, Grumman Aircraft Engineering Corporation, Bethpage, L.I., N.Y.

W. J. Werback, T.M.I.A.S., is on a year's leave of absence from Consolidated Vultee Aircraft to finish work for his Master's Degree in Aeronautical Engineering from the University of Michigan. Address now is 1230 Norfolk, Willow Run, Mich.

Charles W. Whiting, T.M.I.A.S., is a Computer at the Point Mugu field office of Northrop Aeronautical Institute. Address is 830 Cypress St., Hermosa Beach, Calif.

Members Elected

The following applicants for membership or applicants for change of previous grades have been admitted since the publication of the list in the last issue of the REVIEW.

Transferred to Associate Fellow Grade

Chambers, Lester S., M.S. & A.E., Commander, U.S.N.; Technical Asst., Bureau of Aeronautics General Representative (Dayton).

Jenney, William W., M.S. in M.E., Asst. Strength Engineer, Douglas Aircraft Co., Inc. (Santa Monica).

Linnert, Theodore George, B.S. in Ae.E., Head, Engineering & Air Safety Dept., Air Line Pilots Assoc.

Elected to MEMBER Grade

Barth, Jack E., B.S., Structures Engineer "A," Douglas Aircraft Co., Inc. (El Segundo).

Bennett, John W., M.S. in Aero., Captain, U.S.A.F.

Boucher, John H., B.S. in A.E., Flight Test Liaison & Field Engineer, Chance Vought Aircraft Div., United Aircraft Corp. (Dallas).

(Members Elected is continued on page 81)

Guest Editorial

Team-Work for National Defense

Highpoint of the Sixth Annual Military Aeronautics Meeting of the Institute (Air Materiel Command, Dayton, Ohio, October 27–28, 1949) was the dinner address by J. Carlton Ward, Jr. Few people possess Mr. Ward's capability for objective analysis and incisive expression, and he was certainly at his best on that occasion. Against his background of many years in dealing with the military services, he developed the themes of the vital necessity for close and coordinated teamwork between military and civilian agencies for effective weapons development. It is to be regretted that we cannot publish his address in full, but with his permission we quote his summary and conclusions.

"In summary these are the vital considerations:

1. America must preserve her security in a troubled world against a mighty Russia whose manpower is not only overwhelming but also is regarded merely as expendable munition. Russia's national aim is frankly expansionist—Stalin has said over and over again that the two systems (i.e., Marxism and capitalism) cannot exist side by side.

2. America must use technology and not its manpower, should such a conflict materialize. Our traditional recognition (which is the Christian position) of the dignity of man and the destiny of man demands it.

3. Research is mandatory to maintain our dominance. It is the best insurance against an enemy's hostile act, particularly when research is implemented with American production resources and America's genius for organization.

4. Research, as a function, must serve the national policy—not try to determine it or superimpose its judgment for it.

5. Research must, by its very nature, be continuous and will flourish only under long-term planning, along with a feeling of year-to-year security in carrying its programs to a point where their fruitfulness can be determined.

6. Research must not be sacrificed to supposed procurement needs. If so, the *future security* will be greatly impaired, dangerously so. There is no practical way to buy Time in the research function. By nature it is a *sequential* process.

7. Research is only one member of the team consisting also of Development, Production, and Use. It must respect its sister activities. Each must know the other's requirements as well as its limitations. Research is not an end in itself. It would be barren standing alone.

In conclusion I would like to pay high tribute to those officers and men of Wright-Patterson Air Force Base and to those throughout all the allied civil and military branches of the Government who have fought for a proper balance of efforts and of funds between the research, the development, the evaluation, the service test, and the production for final training and for use. Their responsibility has been to sell Research, a seemingly abstract commodity. Yet, if they should fail in their courage, their foresight, and their devotion to the task, the very security of our nation, if not of the entire world, would be in grave danger."

The Avro Jetliner

by

Welman A. Shrader

TO OUR GOOD CANADIAN FRIENDS and neighbors goes the credit for developing and flying the first jet passenger transport ever built on the North American Continent. On October 4, at Toronto, A. V. Roe Canada Limited publicly presented its C-102 Jetliner before a select group of Canadian and American officials and representatives of the aviation industry. (*See* front cover.)

Designed as a 50-passenger short- to medium-range transport, the Jetliner displayed an unusual degree of maneuverability and control on its first official test flight.

Power, furnished by four Rolls-Royce Derwent turbine engines, gives this prototype model a cruising speed of 427 m.p.h. at 30,000 ft. with a gross weight of 60,000 lbs. Normal range with 50 passengers and baggage and with all allowances for taxiing and take-off, stacking, fuel for alternate, instrument approach, etc., is approximately 500 miles. Maximum still-air range without emergency allowances, however, is about 1,400 miles.

While the speed has been increased by the use of jet power, there has been no sacrifice in take-off, climb, and landing performance. The aircraft has been designed to operate from intercity runways of 4,000–5,000-ft. length under standard conditions.

The provision of four engines is a valuable contribution to overall safety, and the combining of engines in twin nacelles enables the engine-failure case to be handled with much less effort and hazard than with the conventional four-engined arrangement.

Fuselage

The fuselage is of circular cross section, is 10 ft. in diameter, and comprises four main components—nose, center section (including the center wing), rear center section, and rear section (including the lower fin).

The forward pressure dome is located immediately forward of the main instrument panel and isolates the nose-wheel compartment from the pressurized region. The rear pressure dome is clamped between the angles of the transport joint that joins the rear center section to the rear section.

All floors are of robust construction to withstand indentation and possible damage from freight and are removable. The center floor panels between the seats are easily removable for servicing the flying and engine controls, electrical conduits and junction boxes, and ventilation ducting.

Four side escape hatches, opening inwards and quickly removable from inside or outside, are provided in the passenger cabin in case of emergency. There is an additional escape hatch in the flight deck for the crew.

Pressure-sealed entrance doors for passengers and crew are located on the port fuselage side at each end of the main cabin. An additional loading door may be provided on the starboard side for the rear baggage compartment.

Wing

The wing is a full-cantilever construction, built in three main sections, and with detachable wing tips. The center portion is integral with the fuselage center section. The structure of the center section, which carries the four power plants, comprises a conventional two-spar arrangement with chordwise ribs and heavy-gage skin covering. The spars are of the twin-boom solid shear-web type. The outer wings are attached to the center section by continuous butt-strap joints, a fact that ensures continuity and efficient use of the stressed-skin structure.

In the outer wings, the two-spar arrangement is used, but heavy-gage skin and stringers take the place of

concentrated spar booms and, at the same time, provide the high torsional stiffness necessary for increased speeds. The inner portions of the outer wing between the spars form the integral fuel tanks. There are four tanks—two port and two starboard.

Ailerons, which extend along approximately 53 per cent of the outer wing span, are of all metal construction, are unbalanced aerodynamically, and are power-assisted hydraulically in the ratio of 5 to 1. The connection to the mainplane is by piano hinges on the upper surface, which gives a completely sealed surface. Internal mass balances are employed, and a manual trimmer is fitted.

Landing flaps, which are hydraulically operated, are of the split type, are metal covered, and extend from the outer wing root to the aileron. Additional dive flaps of the split type are fitted on the center wing, and the aft section of the nacelle. The split flaps on the center wing can also be used as landing flaps. Extension or retraction time is approximately 10 sec.

Empennage

The empennage comprises an upper and lower fin section with high tail plane, double rudder, and double elevator surfaces. The lower fin, which is integral with the fuselage, is of the two-spar twin-boom shear-web arrangement, with extra-heavy-gage skin for torsional rigidity. The tail plane, also of the two-spar arrangement, is attached to the lower fin by high-tensile-steel pins through steel end fittings parallel to the tail-plane spars. The top portion of the fin is fastened to the tail plane by the same method.

The elevators, which are attached by piano hinges to the tail plane, are of the double-surface arrangement; the rear surface is operated manually, and the auxiliary surface is power operated. Electric trimmers are fitted which can be operated manually if desired.

The rudder comprises two unbalanced surfaces: the rearmost, manually operated; and the auxiliary, power-operated. Both are carried on piano hinges on the port side. Normally the manual surface only is required, since the auxiliary surface is brought into play only in the event of engine failure at low speeds. A trimmer is provided, which can be manually operated during operation of the manual surface but which is electrically operated when the auxiliary surface is brought into play.

Undercarriage

A tricycle undercarriage of advanced, yet extremely simple, design is fitted, which incorporates twin wheels on both main and nose units. The nose-wheel unit retracts forward into the nose cavity in front of the forward pressure bulkhead, and the main units, which are hinged adjacent to the mainplane rear spar, retract forward between the spars and, in the "up" position, lie between the jet pipes. The undercarriage may be retracted in approximately 8 sec.

While the cabin is unfinished in the prototype model, allowances have been made for a choice of seating arrangements to suit the needs of the various airlines.

Just when jet transports will become standard equipment on the airlines of North America is anybody's guess; however, much credit is due to the engineers and management of A. V. Roe Canada Limited for pioneering the way towards this ultimate and inevitable goal.

I.A.S. National Meeting Schedule

Thirteenth Wright Brothers Lecture—U.S. Chamber of Commerce Building Auditorium, Washington, D.C.—December 17

Eighteenth Annual Meeting—Hotel Astor, New York—January 23–26, 1950

Fifth Annual Flight Propulsion Meeting—Cleveland—March 24, 1950

Members or organizations wishing to submit papers for presentation at National Meetings should send outlines or summaries to the Committee at least 3 months prior to the meeting.

All papers submitted will be considered for publication in the *Journal of the Aeronautical Sciences* or the *Aeronautical Engineering Review*.

All correspondence should be addressed to
The Meetings Committee
Institute of the Aeronautical Sciences
2 East 64th Street, New York 21, N.Y.

Some Aspects of Turbojet Combustion

A. J. Nerad*
General Electric Company

Introduction

The experience with turbojet combustion, or, more broadly, aircraft gas-turbine combustion, is surprisingly widespread now, with barely a decade marking the period from its first successes to the present. Various types of organizations in many countries have entered this field with the aim of technical and scientific progress. The other jets, the nonrotating jets, no doubt are strong contributing stimuli. Thus, we find Government, academic, and research institutions and fuel and engine manufacturing industries engaged in various phases of combustion study which are applicable to the turbojets.

In the past three years, several papers have been presented by various authors. These papers have dealt with both the details and the general principles of the operational or performance factors of turbojet combustors.[1–6] In this paper, it is intended to discuss some general aspects—in particular, the status of turbojet combustion with respect to a few fundamental parameters—in order to indicate some of the complexities of the problem.

While the turbojet combustor is an apparently simple device mechanically,[1] this appearance may be somewhat misleading because of the close interdependence of the various phases of its design. The hole and louvre arrangement, the fuel-injection characteristics, the degree of uniformity of the air supply, and the nature and location of the ignitor affect one another mutually. This complexity has had the result that a long program of cut-and-try development has been the usual rule, in order to obtain highest performance in all respects from a given design.

In some respects, the performance of the turbojet combustor can be measured against some of the elemental "yardsticks" of combustion. In order to arrive at the reasons for the relatively good showing obtained by such comparison, an explanation of the combustor is necessary.

Elements of Flow in a Combustor

Some of the elements of air flow and combustion in our basic combustor configuration are shown in Fig. 1. This combustor is generally typical of all General-Electric gas-turbine combustors. Undoubtedly, the most important single characteristic of the combustor is the flame stabilization or "anchoring"—that is, the smooth continuous ignition process that occurs in the dome end of the combustor. It is axiomatic that any deficiencies of operation occurring in this "flame-initiating" zone must be compensated for elsewhere at many times the "cost." For this reason, we do everything possible to produce a strong reverse flow of heated air and gas, as shown in Fig. 1. This "back-flow" results in the "ignition eddy," to which we refer as the "tore." This characteristic flow pattern is visualized with some difficulty; and, in order to establish its existence beyond any doubt, various tests have been made with pressure probes, as well as other tests, such as fuel injection into the first ring of holes in the flame tube, instead of injection at the normal fuel-nozzle position. These tests have completely satisfied us that Fig. 1 is truly representative of the flow obtained. Understanding of this "back-flow" may perhaps be arrived at best from a study of the end view of the combustion chamber, as shown at the right in Fig. 1. It is obvious that the eight strong jets of air impacting at the center, as shown, must produce a substantial axial flow both out of and into the plane of the paper. At the dome end, this axial flow will be turned radially outward by the dome and will emerge through the eight substantially unobstructed longitudinal passages that are formed by the "watermelon-slice" spaces between the longitudinal rows of air inlets. It has been found that the strength of this backward flow may be controlled by various design factors, and this is important since best results for turbojet operation are obtained when approximately one fourth of the total air flow goes into the "tore."

One other important point may be seen from a study of this end view. Since the hot burning gases pass in close proximity to the eight incoming air jets, a certain portion of the hot gas is entrained by these relatively cool jets, with the result that extremely rapid preheating of the incoming combustion air takes place. This has a most important effect in obtaining good ignition and combustion characteristics.

The Inflammability Limits

Let us now compare the range of inflammability in the turbojet combustor with that obtained in static tests for ignition limits, and also with the tests of a simple "flame holder" in high velocity air.[2,8,9] This maximum range of the inflammability limits in the static tests for hydrocarbons that are comparable to turbojet fuels is not much over 6 to 1 at atmospheric pressure. For example, for naphtha, the air-to-fuel ratios for the lean

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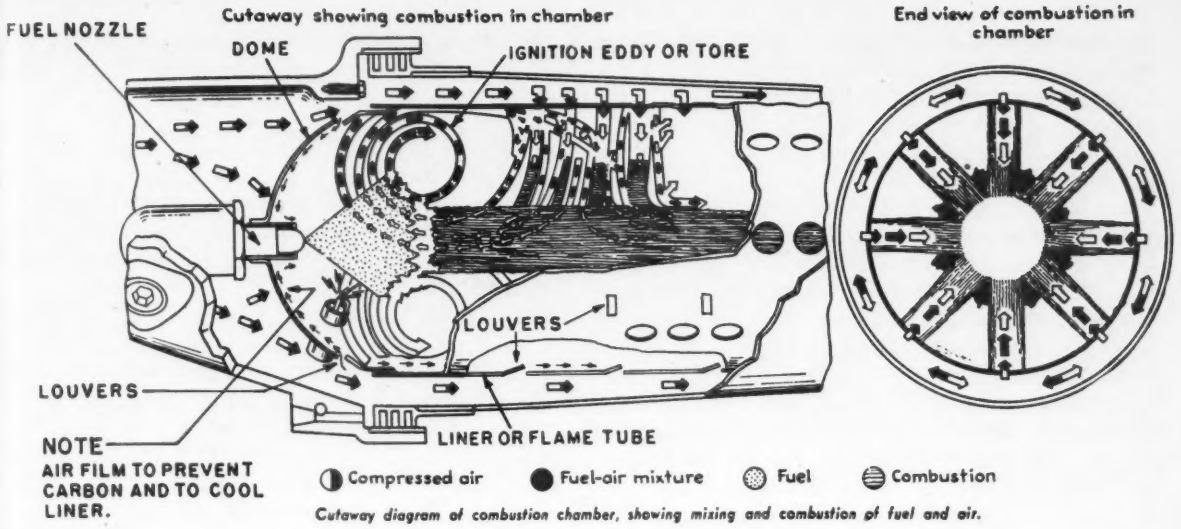
* Head, Mechanical Investigations Division, Research Laboratory.



Cutaway diagram of combustion chamber, showing mixing and combustion of fuel and air.

FIG 1

and the rich inflammability limits are, respectively, 26 and 4.5, or a range of 5.8 to 1. For heptane, they are, respectively 30 and 4.7, or a range of 6.4 to 1. Now for turbojet combustors at atmospheric pressure, in many design configurations, we obtain blow-out limits with a lean value represented by a 50°–100°F. temperature rise through the combustor and a rich value at 2500°F. temperature rise, or better. This corresponds to ranges of 25 to 1 to 50 to 1, which are 4 to 8 times better than the ranges obtained in static inflammability tests. The use of temperature-rise ratio in place of fuel ratios may be conservative in turbojet combustion. A full discussion of all factors involved, including combustion efficiencies, is considered too lengthy to be given here. In the ordinary "flat-plate flame holder,"[8] with 300 ft. per sec. as the velocity of the air-naphtha mixture at 300°F., this range for the inflammability limits was given as 2.7 to 1, or less than half of the static range. The explanation for this phenomenon in the turbojet is due principally to the fact that the flame stabilizing zone, or "tore," appears to shrink or expand to meet the changing air-to-fuel ratios, and thus, the inflammability limits in the actual stabilizing zone probably do not exceed the values from static tests.

Although stability limits widen as initial temperature increases, this appears to have less effect than the change in volume of the stabilizing tore. (There are other implications, and a refinement in the values involved may be made.) It is intended only to illustrate with approximate figures what may be visually observed in actual tests—that is, the shrinkage and expansion of the ignition zone with changes in mixture ratio in the turbojet combustor.

Inflammability limits, whether under static conditions or in the turbojet combustor, decrease with pressure and finally vanish. It is, therefore, of the utmost importance that an aircraft power-plant combustor have as wide a range as is possible in this respect, since operation at low engine speeds and high altitude gives low pressures in the combustor. Table 1 shows the effect of combustion space on the inflammability limits in a developmental combustor:

TABLE 1

Combustor Pressure (Lbs. per Sq.In. Absolute)	Lower Blowout Limit (Temp. Rise, °F.)	Upper Blowout Limit (Temp. Rise, °F.)	Range
2.0	700	700	0
2.4	320	1,350	4.2
3.0	200	1,700	8.5
5.0	90	High (estimated)	20
10.0	80	High	30
14.7	80	High	35

As further clarification of this aspect of the range of inflammability, we might consider a combustor structure in which the "combustion zone" and the "dilution zone" are separated. Then we would expect the combustion zone to have a maximum inflammability range of 6 to 1, and the overall range would be similar. We could, of course, circumvent this limitation by means of a valve arrangement that would vary the relative proportions of air to these two separate zones. It is interesting that, in the aircraft gas-turbine combustors, this has been satisfactorily accomplished without resort to the added complication of such a valve.

Combustion Efficiency

The most used of the "yardsticks" for comparing the quality of the combustion is the combustion efficiency. This would be of only passing interest were it not for at least two results:

(1) In a portion of the very wide range of operation of a turbojet combustor, there appear figures for combustion efficiency as low as 40 per cent. This occurs at quite low engine speeds and high altitudes. Olson

and Bernado have shown this,[4] and it is believed to be representative of turbojet combustion generally.

(2) In operating a turbojet combustion system on various hydrocarbon fuels, sizeable reductions in efficiency are obtained with some of them[2] over part or all of the operating range.

The low efficiencies encountered in a turbojet engine with the ordinary, normal fuels that are used occur at low power and under transient operating conditions at high altitude. The efficiencies at cruising speed and full speed are generally high even at extreme altitudes. In this part of the range they may be above and even well above 90 per cent. This part of the range, which is relatively the more important, may be considered well in hand. The widening of this high-efficiency range has been accomplished through the use of special wide-range fuel nozzles. With such nozzles, some of the peculiar requirements of wide-range combustion may be matched. An important nozzle of this type is the so-called "duplex" nozzle, which has approximately four times the effective atomization range of the simple vortex nozzle for the same fuel-flow requirements and the same limiting fuel pressure.

With further reference to the matter of inflammability limits, the combustor is described as consisting of a dilution zone and a shrinking and expanding ignition zone. Now there are requirements over the operating range which conflict, since the same fuel flow is required for different inflammability limits—that is, different air-fuel ratios. Thus, a fuel nozzle that senses the changes in air-fuel ratio, as well as the changes in flow, is desired. To complicate this further, the entering-air temperature and density vary considerably over this range, and this changes the penetration and evaporation time of the spray. Such considerations as these would make it appear almost impossible to secure wide-range operation of high quality. What saves the situation is that, at high fuel flows, there is a "reatomization" of the liquid fuel that strikes the flame-tube walls. This is due to certain entrainment of the liquid by the air entering the holes, which results in a more uniform fuel distribution that is empirically adjustable through variations in hole and louvre arrangement.

In respect to the effect of fuel characteristics on combustion efficiency, it was felt that combustion with an extreme type of fuel would indicate quite definitely how serious the effects of varying the fuel might be. To test such a type, Bunker C—that is, Number 6 fuel oil—was chosen for its extreme properties in atomization and oxygen requirement (low hydrogen-carbon ratio). In a turbojet combustor, it was found to burn cleanly and efficiently over the range of sea-level operating conditions simply by use of a wide spray-angle air-atomizing type of nozzle and by preheating the fuel. On the other hand, with a standard fuel nozzle, combustion was extremely poor. It may be necessary to do more adjusting than merely changing of the fuel nozzles, in order to burn various other fuels over the full range desired, but this series of tests with Number 6 fuel oil is interpreted as indicating that there are no insurmountable obstacles.

Limiting Area Rate of Combustion

From a theoretical analysis of heat added to fluids flowing in a straight duct, the maximum heat release obtainable on a "cross-section area" basis is definitely fixed. This is a more valuable basis for comparison than a "space rate" basis, since frontal area is at a premium in the aircraft power plant. From this analysis, it appears that when "choking flow" occurs at the exit of a combustion chamber[3]—that is, when the velocity of sound is attained—the limit of heat input is reached for the combustor for a given pressure.

Comparison of present performance in terms of the maximum outer dimensions of the combustor (not merely of the flame tube alone) for some engines on which data have been obtained shows that the heat-release rate has reached approximately one-fourth of the theoretical maximum obtainable with choking flow at the combustor exit. Without considering the penalties of the pressure loss that is entailed in going to higher cross-sectional heat-release rates, such an attainment can be regarded as gratifying when the combustion efficiencies attained are also considered. The losses to be encountered in increasing the intensity of combustion are not only the parasitic losses of friction and mixing but also fundamental momentum and thermodynamic losses. On such a basis, turbojet combustion systems have reached a high level of compactness.

Limiting Volume Rates of Combustion

The volume rates of combustion, however, must not be ignored entirely, since the length of the combustor is affected and any unnecessary length penalizes the engine. In the author's original analysis of the combustion problem in 1941, an attempt was made to determine a crude approximation of the upper limit of energy release in a given volume. With the analysis based on the fundamental flame-propagating velocity of hydrocarbons of 2 ft. per sec. and on the flame-front thickness or the thickness of the active zone of 0.03 cm., it was determined that energy is released in this flame front in an air-hydrocarbon stoichiometric mixture at a space rate at 1 atmosphere of close to 7×10^8 B.t.u. per cu.ft. per hour per atmosphere. This, of course, is far above the choking limit in a straight duct type of combustor. In practice nearly 1 per cent of this value is reached, although demonstrations at 7 per cent of this value have been attained. One explanation for these relatively high values is that high turbulence in the ignition "tore" extends the flame-front area and thus increases the real active volume. From the above rationalizing, it was concluded that the rate of chemical release of energy would not be a limiting factor in turbojet combustion.

(*Continued on page 88*)

Military Air Transport Service Specification Requirements for Cargo Aircraft

RAYMOND R. HAJEK*

Military Air Transport Service

Introduction

At the beginning of World War II, our leaders were confronted with the problem of providing supplies simultaneously to scattered battle fronts in widely separated geographical areas of the world. In order to cope with this problem, it was necessary to introduce a new approach to the science of logistics. This was the creation of a unit whose sole purpose was to provide strategic air transportation to the Armed Services whenever and wherever required. This was the mission assigned to the Air Transport Command and now to the Military Air Transport Service.

In providing this strategic air lift, many types of aircraft were operated. Some had previously been flying the domestic air lines and some were military transports. Reconverted transport aircraft, supplanted with new production C-46 and C-54 (DC-4) aircraft, pushed military supplies to the four corners of the globe. Collectively, the C-47's, C-46's, C-54's, and the C-87 modified Liberator bomber did a remarkable job. Many aircraft that were essentially personnel carriers or bombers were also transformed into cargo aircraft and carried out tasks for which they were never designed.

It is not my intention to repeat facts already known, but it is my intention to outline the types of cargo aircraft that are most suitable for an operation such as the one now being conducted by the Military Air Transport Service and to present the basic specifications for them.

The recent war has proved that comparatively few pieces of material are too large for air transportation. The movement by air of jeeps, light tanks, trucks, vehicles, field guns, aircraft engines, light aircraft, and aircraft components has been commonplace. Before World War II, this would have been considered impossible. To obtain maximum mobility, military planners are demanding aircraft that are capable of furnishing logistic support in large volumes and of airlifting heavily armored vehicles, guns, and tanks weighing up to 25 tons. This does not mean that it will soon be a reality in present or future commercial operations to move 25 tons of heavy cargo by air. It means that, as a result of the demands of the various agencies of the National Defense Establishment, cargo aircraft will be developed to perform the Herculean task of moving by air large numbers of troops and equipment to air heads for launching offenses that would have taken months to prepare for in early wars.

Airlift

The lessons of the last war and of Operation Vittles have shown that airlift for tremendous quantities of supplies can be provided anywhere, at any time, if the emergency is of sufficient importance for the national welfare. In such emergencies, the direct cost must, of necessity, become secondary in importance in the light of the results to be achieved. Unlike the commercial

Presented at the Air Transport Session, Seventeenth Annual Meeting, I.A.S., New York, January 24–27, 1949.

* Major, U.S.A.F., Chief, Aircraft, Material & Equipment Branch, Plans and Operation.

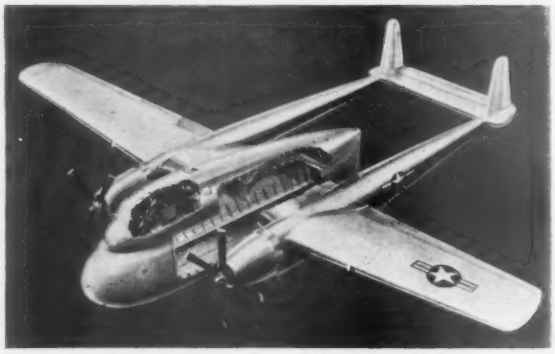
type of operation, where operating costs have always been of utmost importance, military air transportation did not necessarily look to operating cost but to the manner of performance and to what could be done by the best and quickest method. Cost, however, in the light of present day economies, has become a highly important factor in military operations. Airlift can be provided at the cost of maintenance, wherein all available aircraft can be operated to the point of uneconomical maintenance and repair. The constant daily grind of operation to satisfy the all-important need in the past war for the maximum airlift possible has left a major portion of our transport fleet in a poor condition of serviceability. Today, when that same fleet is placed on arduous operation requiring excessive hours of flying, we find out that intensive and costly maintenance must be performed by independent commercial agencies before large numbers of aircraft of the fleet can be ready for a big transportation job. As a member of the Air Transport Command during the war, I have had the opportunity to observe the shortcomings of the various types of aircraft that we operated. When the war started, we were extremely short of cargo aircraft and had to use every available type of aircraft. We had to operate the low-wing airplane with a high floor line and also the converted-type bomber with high wing and a low floor line. We had to operate aircraft with a sloping floor and aircraft with a level floor. All of these complicated operations necessitated specialized handling equipment to load and unload cargo. A few vehicles and some other types of rolling equipment had to be sectionalized in order to make them air-transportable with existing aircraft. Still, we managed to airlift any and everything, with but a slight penalty in time. Military air transportation must be flexible and highly mobile. It must know no barrier, either physical or geographical. It must provide the necessary airlift at any time, anywhere, when the need is of sufficient importance.

Today's cargo aircraft should be flexible enough to be operated by the commercial cargo carriers and, with minor practical changes, to be ready to carry heavy military equipment, cargo, personnel, and air *évacués*. These aircraft should be easy to load and easy to maintain and should have a low overall cost of operation. As a result of this, standardized cargo aircraft would be available to commercial operators and would form a reserve of cargo aircraft for military use in case of a war.

Types of Aircraft

As a result of our past and present experience, it is visualized that several types of cargo aircraft will be required in order to carry out effectively the Military Air Transport Service's assigned mission and its responsibility to the National Military Establishment. Three types with distinctive operational characteristics are needed. These types can be listed as follows:

(a) A long-range heavy-duty transport.



F.G. 1. The Fairchild XC-120 pack-plane, an experimental prototype being developed for the U.S.A.F. The lower half of the fuselage, which is called the "pod," is detachable from the main part of the aircraft to expedite loading and unloading of cargo or passengers.

(b) A medium-range transport.
(c) A short-range utility transport.

Requirements

The cargo aircraft, to be effectively utilized by both the military and the cargo industry, must possess the following prime requisites:

(a) Ease of loading.
(b) Ease of maintenance.
(c) Low cost of operation.
(d) Safety.

Before I discuss these features, let us go back to the three types of aircraft mentioned previously and look at each one individually.

The Long-Range Heavy-Duty Transport

This type of aircraft must be capable of transporting 50,000 lbs. of cargo over a range of 3,000 miles at a cruising speed of 250 knots, or approximately 300 m.p.h., at an altitude of approximately 25,000 feet. It must have an all-out range for ferrying purposes of 5,000 miles and have a service ceiling of 30,000 ft. It should be of a conventional multiengined type, with low floor of truck-bed height for ease of loading. This will naturally necessitate a high-wing design. The aircraft should be capable of operation from 5,000–6,000-ft. runways so that the runways in airports now in existence will be utilized.

The fuselage should be designed for a cargo loading density of $8\frac{1}{2}$ to 10 lbs. per cu.ft. up to a maximum loading of 25 tons and for a floor loading of 250 to 300 lbs. per sq.ft. It must have a width that will permit the loading of bulky items of equipment and cargo in order to utilize the maximum overall tonnage capacity of the aircraft. The width, for present requirements, should be approximately 125 in. The aircraft should be pressurized for high-altitude operation in order to overfly the weather. Suitable deicing, heating, and ventilating systems should be provided. The anti-icing system should be of the thermal type and

should keep the aircraft free of ice under all operating conditions. The fuselage heating system should be capable of delivering sufficient quantities of heat to maintain an average temperature of 65°F. within the aircraft. The aircraft should be equipped with take-off assistance (Jato, or latest-known development). We are beginning to accept the need for reversible propellers that will minimize the length of runway necessary for operation of the aircraft.

From the standpoint of maintenance, servicing, and reduction of ground time, design provisions should be adopted which would attain the following desired results: (1) fuel and oil servicing would be accomplished from the ground without climbing onto or into the aircraft; and (2) the servicing accessibility of major items of equipment—such as radio, hydraulic systems, electrical wiring, etc., which do not require immediate contact by the flight crew during flight—would be arranged so that they could be reached from the ground, thereby eliminating the necessity of entering the aircraft at any time. In field operation, the ease of maintenance is an essential item and should be one of the foremost thoughts in the designers' minds. The aircraft must permit quick engine change. It is becoming more important all the time that aircraft be capable of normal operation over a wide range of climatic conditions with temperatures varying from −65°F. to +120°F.

As the aircraft become larger, ground loads become critical, and changes should be made in the orthodox type of landing gear. A new aircraft should have a load distribution over the surface of the ground, which is not in excess of that now encountered by the C-54.

In order to operate in all types of weather, the aircraft must be provided with the latest radar and radio devices so as to permit operation at the lowest minimums. The aircraft should be designed so as to incorporate the latest and best handling and stability characteristics consistent with the best design practices; it should have c.g. travel that would permit a wide range of balance.

The Medium-Range Transport

This aircraft must be capable of airlifting a cargo load of 12½ tons for a distance of approximately 1,500 miles at a cruising speed of 200 knots at an operating altitude of 20,000 ft., and it must have a ferrying range of 3,500 miles. A service ceiling of not less than 25,000 ft. is desired for this aircraft in order to overfly the weather. As in the case of the long-range transport, the medium-range transport is a heavy-duty type and must possess truck-bed floor height for ease of loading. It should be capable of operating from 4,500- to 5,000-ft. runways. The fuselage must be designed to have an average cargo loading density of 6½ to 8½ lbs. per cu.ft. The aircraft should incorporate most of the features specified for the long-range type. This aircraft could be utilized in interdepot and feeder-type operations.

The Short-Range Utility Transport

This aircraft must be capable of transporting 4–5 tons of cargo over a range of 1,000 miles at a cruising speed of approximately 150 knots per hour and must have an operating altitude of approximately 15,000 ft. One of the principal requirements for this type is that it should be capable of operation in and out of short fields and unprepared landing strips and over rough terrain—it must have short-take-off characteristics. This aircraft should incorporate features that are the same as those outlined for the medium and heavy transports—that is, pressurization, radio, maintenance, etc.

As I have previously pointed out, cargo aircraft, to be effectively utilized by both the Military and the cargo-carrier industries, must possess the prime requirements, such as ease of loading, ease of maintenance, low cost of operation, and safety.

Ease of Loading

For many years, we have used rail transportation and truck freight transportation, which has provided varying floor heights in cars and trucks. Common carriers have standardized on the car and truck floor heights; this, in turn has eased the loading problem. Similarly, in air transportation, ease of loading is an essential requirement that will greatly help to reduce the overall cost of operation. We have learned from actual experience that the C-82 loading and unloading time is less than that of the C-54 or the C-74. The earliest approach to truck-bed-height loading of cargo aircraft was made in the early 30's by Panagra in loading mining equipment. This was done by using ramped dugouts to lower the fuselage for ease of loading. In present-day practice, some operators lower the tail of the DC-4's in order to ease the loading of different types of cargo. At the present time, the only cargo aircraft that offer the solution of the problem are the C-82 Packet, the C-119B, and the proposed Curtiss-Wright Model 32. All three of these have truck-bed-height floors for ease of loading.

From past experience and from study of loading-time requirements, we can foresee the overall effect in savings in both man-hours and the cost of using a low truck-bed-floor-height aircraft. Loading qualities of an aircraft should be such as to permit straightaway loading, so that the maximum cargo cross section of the fuselage could be utilized and various types of bulky equipment and cargo could be loaded in a minimum amount of time. A result of this would be a reduction in the ground time of the aircraft. An aircraft should be designed to permit loading and unloading from normal truck bodies without the use of auxiliary equipment, such as high-lift trucks, fork trucks, etc. It is also essential that the aircraft be provided with a number of cargo doors along the sides of the cargo compartment since this would facilitate the simultaneous loading and disposition of the cargo inside.

FIG. 2. The C-121, U.S.A.F. version of the Lockheed Constellation. Employed in transatlantic service, the C-121 carries 44 passengers or 12,000 lbs. of cargo.

EASE OF MAINTENANCE

To meet this requirement, major aircraft components should be easily accessible, with a minimum of man-hours required to keep the aircraft in operation. Provisions for quick engine changes should be made, and less complicated systems, fuel, hydraulic, electrical, and other systems, any one or all of which tend to complicate the maintenance picture, should be less complicated.

LOW COST OF OPERATION

This requirement is extremely important in light of the present emphasis on economy of operation. Low cost per ton mile, which stems from efficient design, utilization, maintenance, fuel economy, longer service life of the aircraft, and lower loading cost, will result in the delivery, at considerable saving, of a greater amount of pay load. Another result would be that fewer aircraft would be required in the fleet. It would also mean lower investment in aircraft and fewer crews to operate them. The ultimate objective is a direct operating cost of 3.5 cents to 8.5 cents per ton-mile.

PRESSURIZATION

As you may have noted, I have specified pressurization on all three types of aircraft. Pressurization of the aircraft is essential from the standpoint of passenger and crew comfort. On the other hand, there have been differences of opinion on this subject with reference to its application to military cargo aircraft. In the Military Air Transport Service type of operation, where a mixed load is often carried—such as passengers and cargo or passengers and litter patients—pressurization is required when operating at high altitudes. Pressurization is desirable in air evacuation, for it minimizes patient discomfort and tends to eliminate the psychological reaction to oxygen masks. Furthermore, it permits the attendant greater freedom of movement in administering to the patients. It is not a luxury; I believe it to be a necessity. If pressurized, aircraft can overfly adverse weather encountered along the route and avoid all rough air, which will minimize crew discomfort and improve the efficiency of the aircraft.

SAFETY

In the quest of efficient operation, safety should not be overlooked; all-out consideration must be given to this requirement. Crew comfort must be provided as a means of lessening fatigue. Passenger safety, evacuation of the aircraft, crash-landing provisions, and minimization and reduction of fire hazards should all be given careful study so that the designer will come up with an aircraft that will be both efficient and safe for cargo operation.

THE DETACHABLE CARGO COMPARTMENT

One of the most promising developments of the present day in cargo aircraft is the detachable-compartment transport. This development appears to be on the threshold of revolutionizing both military and commercial transportation. A number of studies have been made on this type of aircraft in the past several years. At last it has become a reality. The United States Air Force, in conjunction with the Fairchild Engine and Airplane Corporation, Fairchild Aircraft Division, has undertaken a development of the detachable-cargo-compartment transport aircraft, which, as a prototype, will enable the Services and the cargo carrying industry to learn more of the possibilities that this type of design offers. The pack or detachable cargo compartment is to the aircraft what the highway trailer is to the truck tractor and what the split-cargo-load compartment is to the railroad freight business. It is my personal opinion that as the trailer has infinitely stepped up the efficiency of truck transport, the detachable cargo compartment will virtually triple the transport efficiency of aircraft, particularly in military operations. It is estimated that if a detachable-compartment transport aircraft, the XC-120, had been utilized in the Vittles Operation, a saving of approximately 50 per cent could have been effected. From a rough estimate, it is figured that approximately 120 aircraft of the detachable-compartment configuration, equipped with three packs each, would be required to carry the daily requirement into Berlin.

In an operation of this type, it is apparent that a greater saving could be realized. It is not my intention to go deeply into this problem at this time since many factors must be determined from the prototype in order to draw more accurate conclusions. It is realized that a detachable-compartment transport aircraft, employed in an operation of this or any other strategic type, would not have to be unloaded but would simply have to unhitch the pack, roll over, and take off. Turn-around time would be reduced to a minimum at forward areas or terminals. We in Military Air Transport Service visualize that the detachable-cargo-compartment aircraft of the 50,000-lb.-pay-load class will be capable of providing air transport for:

(a) Conventional, but more rapid, strategic air support. A cargo pod can be quickly detached at the desired station and another loaded pod, picked up. This allows maximum use of the aircraft and keeps loading and unloading time to a minimum.

(b) Mobile control units. Used as a control unit, the pod could be equipped with elaborate communica-

tions equipment and could accompany and control large formations of bombardment and fighter aircraft both on penetration to the target and on withdrawal.

(c) Mobile radio and/or radar homing devices in support of VHB (Very Heavy Bomber) aircraft. The pods could be equipped with homing devices and placed along the route of the bomber stream to provide communications aid where no other installations exist. Pods could be either dropped from the air, using reverse-rocket-thrust methods, or released near the ground by low-flying prime movers.

(d) Mobile hospital units. Small medical units could be air-lifted into a disaster area and the pod could be detached. The prime mover then could be utilized for other missions until the medical unit is no longer needed, at which time a prime mover would return for pickup.

(e) Mobile maintenance repair units. These could utilize the pod in the same manner as the hospital units. The maintenance unit could be air-lifted to aircraft forced down in isolated locations and could efficiently perform relatively major maintenance.

From the above it can be seen that a detachable-type aircraft will:

(1) Reduce the number of aircraft required by the operating agency.

(2) Increase the utilization by two- or threefold.

(3) Reduce the ground handling time and cost to a bare minimum.

(4) Provide flexibility of operation.

(5) Provide storage and transportation space for various types of cargo, supplies, or be used as shelters and housing facilities in various geographical areas.

It is my belief that the detachable-cargo-compartment transport is the ultimate answer in cargo transportation and will eventually satisfy all the requirements of ease of maintenance, ease of loading, low cost of operation, and safety.

Throughout my presentation and discussion of transport aircraft, you may have noticed the grouping that I have given to range, pay load, and speed. I have placed range on a first-priority basis because the maximum range obtainable for a maximum pay load is highly desirable. The range specified for the heavy transport is predicated on the longest overwater flight that we may encounter in Pacific operations or in our North Atlantic operations. As for the pay load, 25 tons is visualized as being the maximum obtainable without ranging into the larger-sized aircraft. It is estimated that an aircraft capable of carrying this 25-ton pay load would gross approximately 150,000–180,000 lbs. Many of you may disagree with this, but from studies that have been made and from a review of the designs in production and a few on the board, I can safely say that this would not be impossible.

Speed

We now come to speed, which I have placed in the lower priority, since speed is not as important to our operation as it would be to commercial types. We do not visualize that any operation beyond the speed that I have indicated will be made without penalizing the performance and capabilities of the aircraft. Though speed is of some importance since we are not a premium-type transportation unit, we do not require the speed necessary to air-line-type operations.

Fig. 3. The Douglas DC-7 Globemaster (C-74), which can transport 125 troops, 109 litters, or 49,000 lbs. of task-force material. Special features are an integral elevator of 1-ton capacity and a fixed hoist for loading cargo through a side door.

Jet Transports

This leads me, then, to the subject of jet transportation. At present, we do not foresee the use of an aircraft of this type in our operation for several years to come. An aircraft of this nature must be fully developed and shaken down so that it can be efficiently utilized in a cargo-carrying capacity. In its present projected stage, it appears to be uneconomical and could not be applied efficiently to the transportation of cargo without having high cost attached to it.

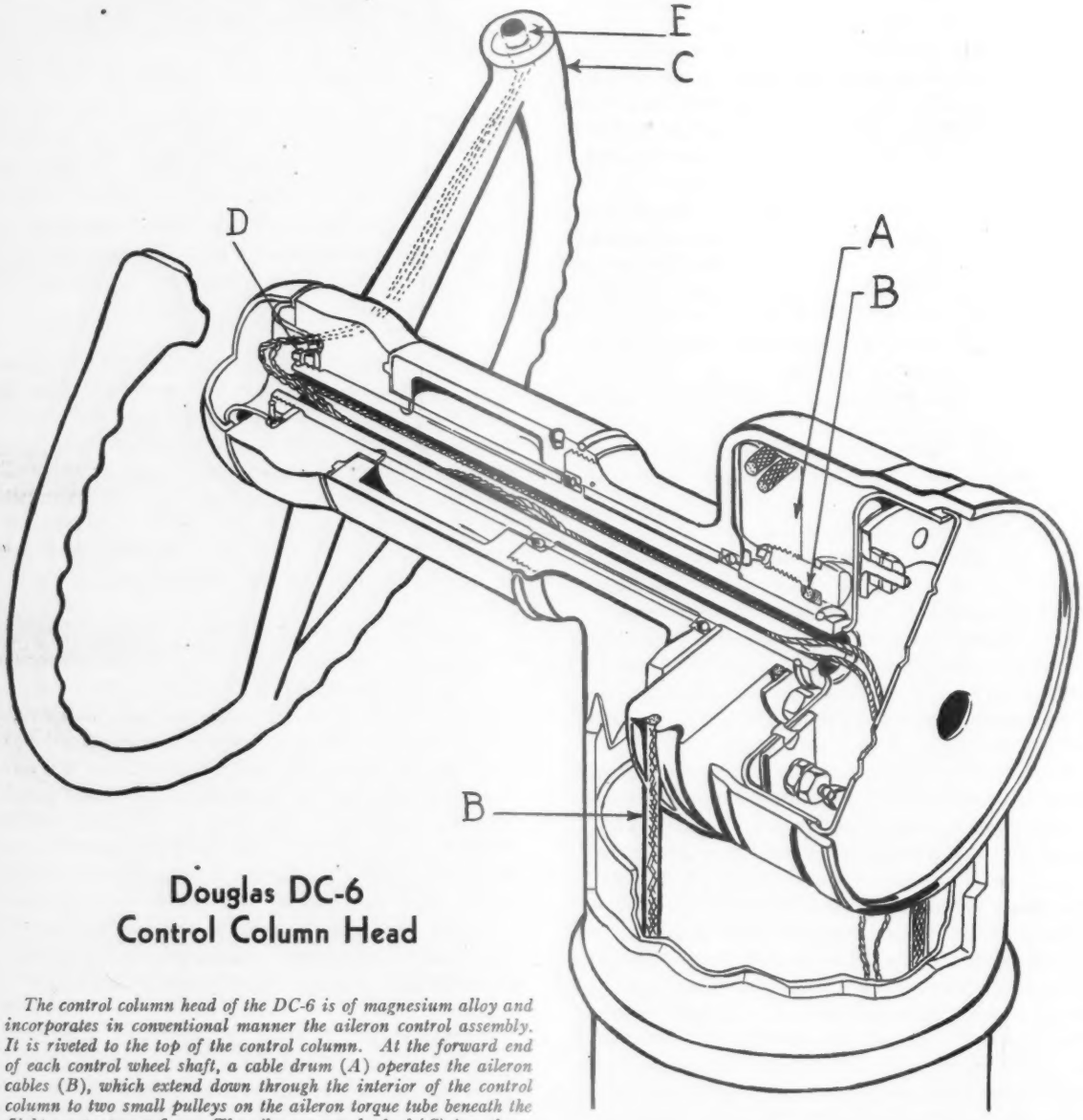
Summary

In looking over the broad picture of air transportation and the requirements of the Military Air Transport Service plus those of the cargo-carrying industry, I have presented a few requirements and specifications of what are considered to be cargo aircraft that will meet our needs and possibly the needs of the cargo people. I have emphasized in the same priority, the requirements for range, pay load, and speed. I have discussed the basic specifications for the type of aircraft required, and I have emphasized the prime requirements—namely, ease of maintenance, ease of loading, low cost of operation, and safety. These, all molded together, define the type of cargo aircraft which we consider to be desirable.

A cargo aircraft, in order to perform the mission required of it, must be designed for that purpose; to rely in the future on reconverted commercial aircraft and other makeshift types will be costly, inefficient, and an outright gamble with national security. Unless a cargo aircraft is designed to meet the requirements of the Military Air Transport Service and the cargo-carrying industry, we will continue to be confronted with the never-ending problem of trying to deliver the goods with inadequate equipment, and until such a design is forthcoming, our problem will continue to be with us.

Design Trends

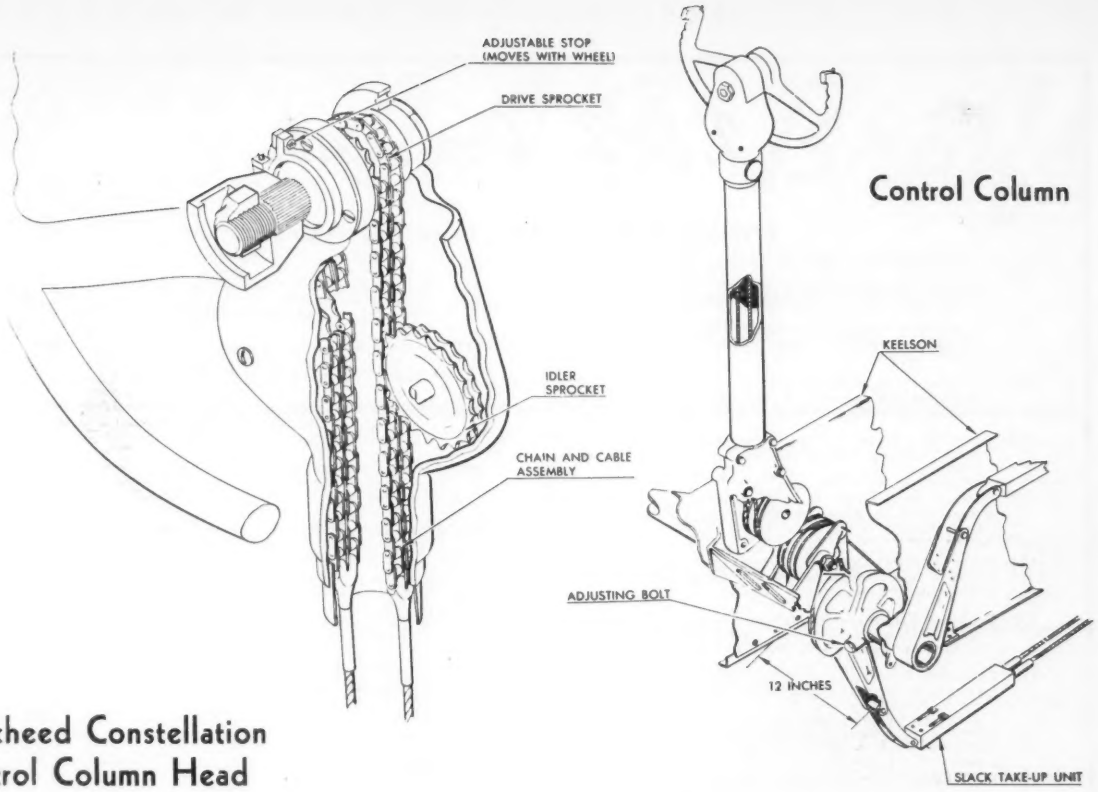
Surface Controls



Douglas DC-6 Control Column Head

The control column head of the DC-6 is of magnesium alloy and incorporates in conventional manner the aileron control assembly. It is riveted to the top of the control column. At the forward end of each control wheel shaft, a cable drum (A) operates the aileron cables (B), which extend down through the interior of the control column to two small pulleys on the aileron torque tube beneath the flight-compartment floor. The aileron control wheel (C) is a three-quarter-circle magnesium-alloy casting, coated with insulating plastic. The casting has serrations to match those on the shaft, thus enabling the wheel to be exactly centered on the shaft and fastened with a retaining nut (D). A seal ring prevents bearing grease from escaping at the retaining nut. A hub cap snapped on conceals the nut. The wheel and control pulley shaft rotate in the control-column head. Fixed stops incorporated in the head and on the drum limit the rotation of the cable drum. Instrument light wires are routed from a push-button switch (E) on the wheel and then to the junction box in the control-column head.

IN THE JULY, 1949, issue of the REVIEW were illustrated the Boeing solutions for certain flight-control problems posed by the large airplane in which, in place of the usual control column design where control cables go up into the head, a gear-driven type was utilized in the Stratocruiser with aileron and elevator cables attached to a drum and quadrant at the base of the column. Here, in this issue, are presented two variations of the orthodox design as represented in Douglas and Lockheed practice.



Lockheed Constellation Control Column Head

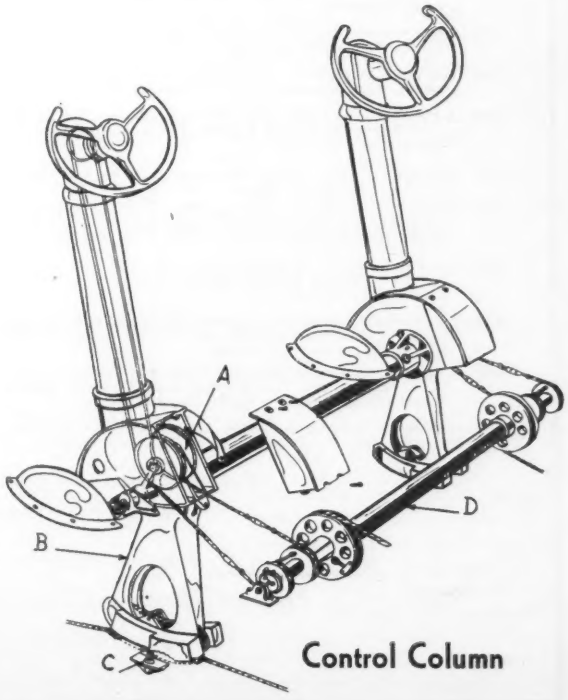
Control Wheel: *In the Constellation, an aileron control wheel, mounted on each of the control columns, operates the ailerons. A chain and cables, engaging with a drive sprocket on the control wheel shaft and idler sprocket, operates the flight-station aileron walking beam.*

Control Column: *The cables are routed over pulleys at the bottom of the control column and connect to quadrants on the aileron flight-station torque tube. Walking beams are attached to the torque tube. Stops in the control column limit control-wheel travel to 126° in each direction. Elevator surfaces are controlled by fore-and-aft motion of the dual control columns. A link from the control column converts fore-and-aft motion of column to rotary motion of torque tube to which flight-station walking beam is attached. Adjustable stops limit walking beam travel to 41° each side of center. Mid-travel position of control column gives 12° "up" elevator. A cable system connects flight-station controls to a walking beam on the elevator booster. Booster actuating cylinder acts as control-surface stop for the elevators, limiting travel to 40° "up" and 20° "down" elevator.*

Douglas DC-6

Each control column *of the Douglas DC-6 (as well as in DC-4 and Canadair North Star airplanes) is a spot-welded aluminum tube to the top of which is riveted the magnesium-alloy head. An aluminum-alloy base contains cable pulleys (A) for the aileron cables that descend through the interior of the column. On the outboard side of each base, a ball-bearing bracket, on which the control column moves forward and aft, is bolted to the flight compartment floor beam.*

At the base of each control column, *under the floor, is a triangular sector (B) containing the attachment provisions for "up" and "down" elevator cables. Adjustable stops (C) on these triangular sectors limit fore-and-aft movement of the control columns. Separate two-way cable systems connect each control column to the two elevator-operating bellcranks on the two small torque tubes in the tail section. A torque-tube assembly (D) connects the two control-column bases and effects identical movement of both columns. This aileron torque-tube assembly is supported on ball-bearing blocks bolted to sheetmetal brackets riveted to the subfloor structure beneath the pilots' seats. The assembly consists of a torque tube with four small and two large pulleys fastened to it with taper pins. The four small pulleys, controlled by the wheels in the flight compartment, actuate the assembly, and the two large pulleys transfer this motion into the main aileron cable system. The cables are bolted to the pulleys and are prevented from slipping out of their grooves by castings bolted to the side of each support bracket. Metal retainers screwed to the sides of the large pulleys prevent the main cables from slipping out of their grooves when in the extreme positions.*



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Tung-Hua Lin

Chinese Bureau of Aircraft Industry

In this paper the buckling of a pin-ended column with small initial curvature in the plastic range is investigated. The initial curvature is unavoidable in actual columns because of eccentricity and nonhomogeneity of materials. A method of calculating the deflection of a column with known small initial deflection up to the maximum load is shown, and an illustrative example is given. From the load-deflection curve, the maximum load is obtained. The effect of reversal of strain on the middle part of the column on the convex side, when the load and deflection are big as described by Shanley,[1,2] and the effect of variation of tangent modulus of elasticity across the section are analyzed. The load at which this reversal of strain starts and the method of calculating the extent of the reversal of strain on the cross section are shown. The theoretical analysis given in this paper shows the different factors affecting maximum load and the mechanism of column failure. The method of computing the deflection curve at each load is shown so that the shortening of the column can be found. This may be required for analyzing an indeterminate structure with inelastic columns as members.

The mechanism of the start of deflection of a perfect column without initial curvature is explained, and the proposed method for calculating the load-deflection curve can also be applied to a perfect column and its maximum load can be determined.

The Calculation of Supersonic Downwash Using Line Vortex Theory

By

Harold Mirels and Rudolph C. Haefeli

Lewis Flight Propulsion Laboratory, N.A.C.A.

A straightforward procedure, based on lifting-line theory, is presented for obtaining the downwash behind lifting surfaces at supersonic speeds. The customary assumptions of an inviscid fluid and small perturbation velocities are made.

In particular, the vortex field associated with a supersonic lifting surface is examined; the vertical perturbation velocity field due to a line vortex segment of constant slope is presented in explicit form and is utilized to discuss some of the properties of line vortexes in a supersonic free stream; a bent lifting-line method and an unbent lifting-line method (horseshoe vortex system) are proposed for determining the downwash field behind swept and unswept wings, respectively. The lifting-line methods are applied to triangular and rectangular wings and give results that are in close agreement with the exact linearized solutions.

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See page 34 for Preprints that are immediately available.

The Theoretical Lateral-Stability Derivatives for Wings at Supersonic Speeds

By

Arthur L. Jones

Ames Aeronautical Laboratory, N.A.C.A.

Results available on lateral-stability derivatives for wing plan forms at supersonic speeds are summarized. The effects of aspect ratio and Mach Number are studied primarily, and subsonic values for the derivatives are included in the investigation of the Mach Number effects. Nonlinearities in the sideslip variation of the yawing and rolling moments are considered briefly, and the effects of combining a wing and body are indicated for two of the derivatives.

Predictions of Supersonic Airplane Performance

By

Harold Luskin

Douglas Aircraft Company, Inc.

Previous writers on the history and prediction of the trend in airplane maximum speeds have sometimes represented the trend as being linear with time. This paper discusses the more general type of growth curve in relation to airplane speeds. Limiting factors in airplane performance are studied, and prediction is made for supersonic developments expected to be possible by 1960. It is pointed out that increases in speed and improvements in the safety record have been obtained simultaneously, in spite of increasing wing loadings. This trend is expected to continue.

Influence of Acceleration on Aerodynamic Characteristics of Thin Airfoils in Supersonic and Transonic Flight

By

C. S. Gardner and H. F. Ludloff

New York University

An attempt has been made to derive the aerodynamic characteristics, in the supersonic and transonic range, of a two-dimensional airfoil moving at uniformly accelerated speed; it is assumed that the airfoil is thin and the shocks resulting from its motion are extremely weak. Under these conditions, the airfoil motion may be treated as a time-dependent perturbation problem, which can be solved by means of "Possio solutions." The solutions for lift, drag, and pressure on the airfoil surface turn out to be elliptic integral expressions, whose arguments depend on the Mach Number and on an acceleration parameter.

The evaluation of these solutions is carried out in a different manner, depending on whether the transonic or the supersonic range is considered. In Part A, the solution at supersonic speeds is expanded in *positive* powers of the acceleration parameter β. The influence of acceleration turns out to be extremely small. In Part B, the transonic range is treated by expanding the expressions for lift and drag, at $M = 1$, into a series starting with the *negative* one-fourth power of β. This elucidates why, at $M = 1$, the theoretical expressions for the aerodynamic parameters remain *finite* in the case of *accelerated* motion but become infinite in the limit of stationary flight speed ($\beta = 0$). In Part C, a physical discussion of the results for wedges and diamond-profiles is given: The curves representing the aerodynamic parameters as a function of the Mach Number have a more or less pronounced maximum at $M = 1$, depending on the value of the flight acceleration β. The application of a validity criterion shows that for sufficiently "large" β the results can be taken quantitatively, while at "small" β the results have only qualitative meaning.

A Note on Approximate Plane Motion During the Burning Period of Rocket-Propelled Missiles Launched at Small Angles of Yaw from Aircraft

By

Ray E. Bolz

Rensselaer Polytechnic Institute

The differential equations of plane motion during the burning period of a rocket-propelled missile launched from a moving airplane are written, simplified for approximate application to small angles of yaw (20° or less), and solved. In writing the equations of motion, the gravitational force is neglected, as well as the influence of any pitching disturbances on the yawing forces or moments.

The solution determines the approximate motion of the center of gravity and the spatial orientation of the missile axis as a function of missile design, the initial launching conditions, and the distance along the trajectory. The results are plotted in generalized coordinates, and the curves may then be used for the solution of specific cases.

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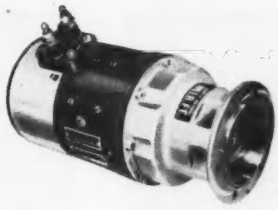

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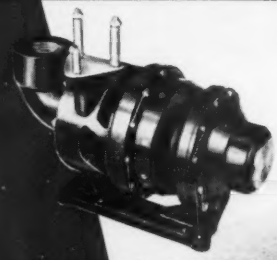

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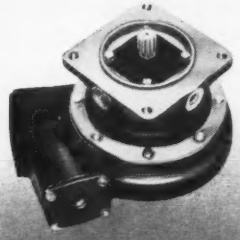

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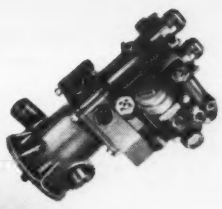

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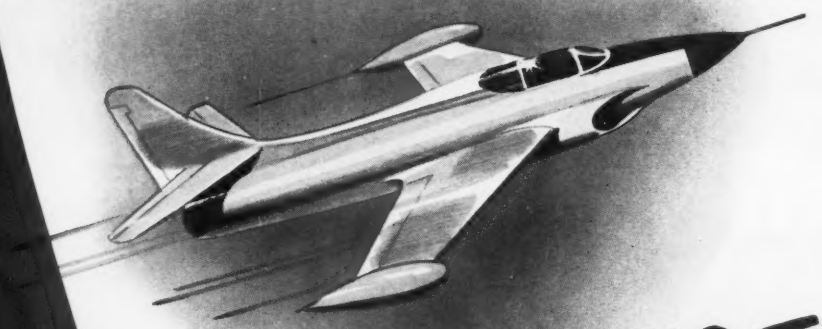

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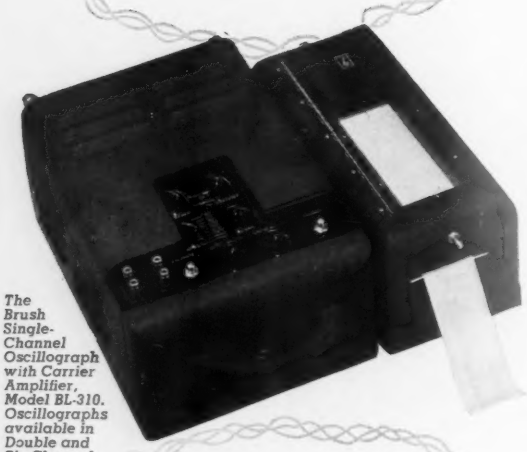

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Aerodynamics (2)

BOUNDARY LAYER

Effects of Sweep-Back on Boundary Layer and Separation. Robert T. Jones. *U.S., N.A.C.A., Report No. 884,* 1947. 3 pp., figs. 6 references. U.S. Govt. Printing Office, Washington. $0.10.

Following the law of stress adopted in the Navier-Stokes equations, the configuration of the viscous flow in planes at right angles to the axis of an infinite cylinder is found to be independent of the axial motion of the cylinder. In the limiting case of a yawed or swept wing of very high aspect ratio, certain boundary-layer and separation phenomena are thus determined independently by the crosswise component of velocity. It follows that the effect of sweepback is to increase the area of stable laminar flow and to decrease the lift coefficient at which flow separation occurs.

Interaction Between the Laminar Boundary Layer Over a Plane Surface and an Incident Oblique Shock Wave. Lester Lees. *Princeton University, Aeronautical Engineering Laboratory, Report No. 143,* January 24, 1949. 62 pp., figs. 10 references.

The problem is treated by separating the flow in the immediate vicinity of the shock from the remainder of the flow in the viscous gas layer adjacent to the surface. Away from the shock wave, the ordinary boundary-layer theory remains valid, and the properties of the main supersonic flow are used with a modified Pohlhausen method for calculation of the boundary-layer flow. The pressure rise communicated upstream of the shock wave through the subsonic portion of the boundary layer decays exponentially with distance from the shock, and the flow separation determines the shock reflection condition. The subsonic reversed flow near the surface downstream of the separation cannot support a pressure discontinuity and the incident shock wave is reflected as an expansion "fan" which cancels the pressure rise across the shock. The flow is deflected back toward the surface and reattaches itself to the surface at a distance downstream of the shock.

On the Stability of the Free Laminar Boundary Layer Between Parallel Streams. Martin Lessen. *U.S., N.A.C.A., Technical Note No. 1929,* August, 1949. 31 pp., figs. 22 references.

The laminar boundary layer between parallel streams is an unstable-flow configuration except at low Reynolds Numbers. The method of calculation of stability characteristics is successful for small absolute values of the parameter $(-i/uR)$. In comparison with Blasius-type flow against a flat plate, instability occurs at much lower Reynolds Numbers for the free boundary layer than for the boundary layer against a flat plate with no pressure gradient.

Investigations of Effects of Surface Temperature and Single Roughness Elements on Boundary-Layer Transition. Hans W. Liepmann and Gertrude H. Fila. *U.S., N.A.C.A., Report No. 890,* 1947. 12 pp., illus., diagrs., figs. 14 references. U.S. Govt. Printing Office, Washington. $0.15.

The laminar boundary layer and the position of the transition point were investigated on a heated flat plate. The Reynolds Number of transition decreases as the temperature of the plate is increased. It is shown, from simple qualitative analytical considerations, that the effect of variable viscosity in the boundary layer due to the temperature difference produces a velocity profile with an inflection point if the wall temperature is higher than the free-stream temperature. This profile is confirmed by measurements. Furthermore, it is confirmed that, even with large derivation from the Blasius condition, the velocity and temperature profiles are very nearly identical, as predictable theoretically for a Prandtl Number of the order of 1.0. The instability of inflection-point profiles is discussed. Studies of the flow in the wake of large, two-dimensional roughness elements are presented. It is shown that a boundary layer can separate and reattach itself to the wall without having transition take place.

Influence of Compressibility Upon the Transition Point of the Boundary Layer. Sighard Hoerner. *U.S., Air Force, Technical Report No. F-TR-2184-ND,* January, 1948. 9 pp., figs. 11 references.

The negative pressure gradient on the sides of bodies and profiles, favorable to retardation of the transition point from laminar to turbulent flow, is increased by compressibility effects. Several measurements on spheres and slender bodies verify the hypothesis that the critical Reynolds Number, one factor upon which the

transition point depends, is increased by compressibility. For laminar profiles, where favorable negative pressure gradient is attained by locating the section of maximum thickness far back on the profiles, compressibility effects cause a definite prolongation of the critical Reynolds Number beyond the point previously indicated as the limit of practicability for these airfoils. These considerations therefore encourage the further use of laminar airfoils for aircraft operating in the compressibility range.

Experimental and Theoretical Studies of Area Suction for the Control of the Laminar Boundary Layer on a Porous Bronze NACA 64A010 Airfoil. Dale L. Burrows, Albert L. Braslow, and Neal Tetervin. *U.S., N.A.C.A., Technical Note No. 1905,* July, 1949. 53 pp., illus., diagrs., figs. 8 references.

By the application of area suction, an airfoil having a porous surface of sintered bronze that was neither aerodynamically smooth nor fair gave combined wake and suction drags lower than the drag of a plain airfoil. Virtually full-chord laminar flow was obtained up to a Reynolds Number of approximately 8.0 by 10^6. Results indicated the possibility of extending the low-drag characteristics to larger Reynolds Numbers by means of a more uniform chordwise distribution of suction inflow. The stabilizing action was manifest despite the adverse effects of surface protuberances, but the data were insufficient to determine the practical value of area suction for laminar boundary-layer control.

Measurements in the Boundary Layer of a Yawed Wing. A. M. Kuethe, P. B. McKee, and W. H. Curry. *U.S., N.A.C.A., Technical Note No. 1946,* September, 1949. 16 pp., illus., figs. 6 references.

Measurements of the velocity profiles in the turbulent boundary layer on the upper surface of a wing of semielliptical plan form at an angle of yaw of 25° and angles of attack of 12 and 14° are reported along with pressure distributions. These show considerable spanwise flow near the surface. The chordwise (velocity components inclined 25° to the main wind direction) and spanwise boundary layers were calculated. The chordwise velocity profiles are in good agreement with those obtained at the National Bureau of Standards on an unyawed airfoil shape.

Behavior of the Laminar Boundary Layer for Periodically Oscillating Pressure Variation. August Wilhelm Quick and K. Schröder. (*Deutsche Akademie der Luftfahrtforschung, Schriften, Ludwig Prandtl zum 70. Geburtstage, 1945, pp. 247–255.*) *U.S., N.A.C.A., Technical Memorandum No. 1228,* September, 1949. 9 pp., figs. 1 reference.

An extract of theoretical results from a more detailed report on the growth of the laminar boundary layer on an undulated surface. For a surface which was undulated about the mean of a flat plate, the drag was shown to be appreciably less than that for a flat plate at very low Reynolds Numbers. However, the onset of transition on the undulated plate occurred at lower Reynolds Numbers than on the flat plate.

Boundary Layer Effects on Spinning Spheres. Harold Wayland and Frank G. White. *Heat Transfer and Fluid Mechanics Institute, University of California, Berkeley, Calif.,* June 22–24, 1949, pp. 51–64, illus., figs. 7 references. American Society of Mechanical Engineers, New York. $5.00.

Interferometric Studies of Beginning Turbulence in Free and Forced Convection Boundary Layers on a Heated Plate. Ernst R. G. Eckert. *Heat Transfer and Fluid Mechanics Institute, University of California, Berkeley, Calif.,* June 22–24, 1949, pp. 181–190, figs. 12 references. American Society of Mechanical Engineers, New York. $5.00.

CONTROL SURFACES

The Effects of Aerodynamic Brakes Upon the Speed Characteristics of Airplanes. Jack D. Stephenson. *U.S., N.A.C.A., Technical Note No. 1939,* September, 1949. 34 pp., illus., figs. 7 references.

In this report various uses of aerodynamic brakes are discussed. Since the brakes are primarily a means of controlling the speed of an airplane, methods of calculating the speed and speed variations are presented. A graphical procedure is described which substantially reduces the time required for a step-by-step calculation of the speed, altitude, and dive-angle relationships for airplanes in maneuvers involving normal accelerations. A summary of data showing increments of drag coefficient measured in wind tunnels or in flight for various wing and fuselage aerodynamic brakes is included.

Investigation of Spoiler Ailerons for Use as Speed Brakes or Glide-Path Controls on Two NACA 65-Series Wings Equipped With Full-Span Slotted Flaps. Jack Fischel and James M. Watson. *U.S., N.A.C.A., Technical Note No. 1933,* August, 1949. 60 pp., diagrs., figs. 16 references.

Contains results and discussion of an investigation of plug and retractable ailerons used as speed brakes or glide-path controls on an N.A.C.A. 65–210 wing and an N.A.C.A. 652–215 wing of aspect ratio 5.76 equipped with full-span slotted flaps. Incremental lift, drag, and pitching-moment data are presented for various flap conditions through a large angle-of-attack range at Mach Numbers from 0.13 to 0.71. Analysis indicates that this use of spoiler ailerons is feasible and desirable for normal or emergency operation of airplanes. These speed brakes or glide-path controls would probably have small effect on wing pitching moments and should retain their rolling effectiveness.

Flight Measurements of the Lateral Control Characteristics of Narrow-Chord Ailerons on the Trailing Edge of a Full-Span Slotted Flap. Richard H. Sawyer. *U.S., N.A.C.A., Report No. 883,* 1947. 5 pp., illus., figs. 4 references. U.S. Govt. Printing Office, Washington. $0.10.

Low-Speed Experimental Investigation of a Thin, Faired, Double-Wedge Airfoil Section With Nose and Trailing-Edge Flaps. Leonard M. Rose and John M. Altman. *U.S., N.A.C.A., Technical Note No. 1934,* August, 1949. 22 pp., illus., figs. 1 reference.

Linearized Theory of Supersonic Control Surfaces. P. A. Lagerstrom and Martha E. Graham. *Douglas Aircraft Company, Inc., Report No. SM-13060,* July 24, 1947. 49 pp., figs. 6 references.

Methode ter Berekening van de Belasting op het Horizontale Staartvlak van een Vliegtuig Tijdens het Optrekken uit de Horizontale Vlucht, Rekening Houdend met de Vertraagde Instelling van de Luchtkrachten op den Vleugel en en het Hoogteroer (Tail Load During a Pull-Up From Horizontal Flight). IV. *Netherlands, Nationaal Luchtvaartlaboratorium, Amsterdam, Rapport Nr. V.1376,* January 4, 1946. 22 pp., figs. 5 references. (In Dutch.)

Staartvlakbelasting bij het Optrekken uit Horizontale Vlucht. V.—Berekeningen Voor de Douglas DC-2 en de Fokker G-1 (Tail Load During a Pull-Up From Horizontal Flight.) V. *Netherlands, Nationaal Luchtvaartlaboratorium, Amsterdam, Rapport Nr. V.1396,* February 5, 1947. 6 pp., figs. 5 references. (In Dutch.)

FLUID MECHANICS & AERODYNAMIC THEORY

Methods for Calculating the Flow in the Trefftz-Plane Behind Supersonic Wings. P. A. Lagerstrom and Martha E. Graham. *Douglas Aircraft Company, Inc., Report No. SM-13288,* July 28, 1948. 45 pp., diagrs. 7 references.

By means of the linearized nonviscous theory, methods are developed using the complex functions of conical flow, for finding downwash and sidewash at an infinite distance downstream, behind a supersonic wing. Equations are derived which describe this flow field behind several types of "flat plate" wings: the wide delta wing, the trapezoidal wing (wide delta wing with cut-off tips) and the delta control surfaces (a narrow delta wing the two sides of which are deflected differentially). Graphs are included which show the results for these cases, and also, in greater detail, the results for a previously treated case, that of the narrow delta wing (Douglas Report SM-13007). The plane of the wing flow field is characterized by infinite upwash straight behind the wing tips (which indicates that viscous effects are important there), and, in the case of the delta wings and control surfaces, by a region of constant downwash behind the wing. These conditions are modified immediately upon moving above or below the plane of the wing. The flow field behind the delta control surfaces, the two sides deflected equal amounts in the opposite direction, does not vary with changes in Mach Number.

Pressure Distribution on Slender Conical Bodies of Nearly Circular Cross-Section in Supersonic Flow. E. W. Graham. *Douglas Aircraft Company, Inc., Report No. SM-12076 (Preliminary),* May 21, 1947. 11 pp.

Following Busemann's method the linearized equation in conical coordinates is used with constant pressure along each ray. Since the pressure then satisfies the Laplace equation in planes perpendicular to the flow, it can be expressed as the real or imaginary part of a Taylor's series in the complex variable. From the equations for irrotational flow expressions for radial

and tangential velocity are derived. Assuming small periodic perturbations of the cross section of a circular cone, the boundary equation is solved and an expression is obtained for pressure coefficient as a function of amplitude and period of the disturbance.

On Conditions for Steady Plane Flow with Shock Waves. T. Y. Thomas. *Journal of Mathematics and Physics*, Vol. 28, No. 2, July, 1949, pp. 91–98, fig. 3 references.

A proof that a shock wave originating at the vertex of a pointed obstacle in plane flow, will be fixed in the plane of the flow, and the flow behind the shock will be steady if the inclination of the shock line is nonsingular relative to the Mach Number of the uniform incident flow.

Slender Bodies in Supersonic Flow; Seminar IV & V. E. W. Graham. *Douglas Aircraft Company, Inc., Report No. SM-13502*, December 14, 1948. 53 pp., figs.

IV. The use of quadripole distribution of sources and sinks in developing noncircular cross sections of constant cross-sectional area. V. Bodies of revolution and noncircular cross sections that are geometrically similar throughout the length of the body.

Pressure Distribution on Bodies of Revolution in High Subsonic Gas Flows. I. I. Eterman. (*Prikladnaia Matematika i Mekhanika, U.S.S.R., Vol. 11, 1947, pp. 363–370.*) *U.S., Air Force, Technical Report No. F-TS-1222-IA*, May, 1949. 17 pp., figs. 2 references.

A supplement to the method of S. A. Christianovich which enables an approximate determination to be made of the flow contour in a frictionless plane. A procedure is indicated for integrating the equations of Christianovich.

Two-Dimensional Compressible Flow in Centrifugal Compressors With Straight Blades. John D. Stanitz and Gaylord O. Ellis. *U.S., N.A.C.A., Technical Note No. 1932*, August, 1949. 76 pp., figs. 3 references.

Six numerical examples of steady, two-dimensional, compressible, nonviscous flow in centrifugal compressors with straight blades. A seventh example is presented for incompressible flow. The solutions also apply to radial-flow turbines with rotation and flow direction reversed. The effects of variations in following parameters were investigated: flow rate, impeller-tip speed, variation of passage height with radius, and number of blades. The numerical results are presented in plots of the streamlines, constant Mach Number lines, and constant pressure-ratio lines. Correlation equations are developed whereby the flow conditions in any impeller with straight blades can be determined for all operating conditions.

Contribution to the Problem of Flow at High Speed. C. Schmieden and K. H. Kawalki. (*Lilienthal Gesellschaft für Luftfahrtforschung, Bericht S 13/1, 1942, pp. 40–68.*) *U.S., N.A.C.A., Technical Memorandum No. 1233*, June, 1949. 96 pp., figs. 7 references.

In the first part it is shown that the power series representations by Prandtl-Busemann (developed by Hantsche-Wendt) and Janzen-Rayleigh are simply related. The limit of convergence of the Prandtl-Busemann series is also discussed. Furthermore, errors in Goertler's paper are pointed out. In the second part a second approximation is given for the maximum velocity of an ellipsoid of revolution and compared with results for thin bodies (Prandtl-Glauert) and for spheres (Lamla).

Moments of Cambered Round Bodies. Günther Kempf. (*Deutsche Akademie der Luftfahrtforschung, Schriften, Ludwig Prandtl zum 70. Geburtstage, 1945.*) *U.S., N.A.C.A., Technical Memorandum No. 1227*, August, 1949. 15 pp., illus., figs. 1 reference.

Results are presented for the moments and position of force centers of a series of cambered round bodies derived from a torpedo-like body of revolution. The effects of placing fins on the rear of the body of revolution are included.

Line-Vortex Theory for Calculation of Supersonic Downwash. Harold Mirels and Rudolph C. Haefeli. *U.S., N.A.C.A., Technical Note No. 1925*, August, 1949. 54 pp., figs. 10 references.

The perturbation field induced by a line vortex in supersonic stream and the downwash behind a supersonic lifting surface are examined to establish approximate methods for determining the downwash behind supersonic wings. Lifting-line methods are presented for calculating supersonic downwash. A bent lifting line and an unbent lifting line (horseshoe-vortex system) are used to compute downwash behind rectangular wings. The results are compared with the exact linearized solutions.

Connection Between Wall Curvature and Shock Wave Curvature in Two-Dimensional Gas Flows. M. Schaefer. (*Dresden, Technische Hochschule, 1942. Peenemünde Archiv 44/8.*) *U.S., Air Force, Technical Report No. F-TS-1202-IA*, January, 1949. 22 pp. 4 references.

The development of two methods of calculating supersonic flows, and their application to the behavior of a shock front in the neighborhood of its origin on the surface of a body, particularly the effect of the curvature of the surface on the curvature of the shock wave. The method of characteristics, which had formerly been used almost exclusively in the form where the differential equations are approximated by difference equations, becomes inaccurate when large velocity changes occur within a small area such as that near any singularity in the flow. For these cases, methods are required which do not depend upon approximation by difference equations but which proceed directly from the differential equations. The first of the two fundamentally different methods begins with the characteristic differential equations, while the second proceeds directly from the equations of continuity and vorticity for gas flow. The second method, therefore, is not limited to the case where supersonic flow prevails behind the compression shock.

Calculation of One-Dimensional Gas Flows. B. M. Kiselev. (*Prikladnaia Matematika i Mekhanika, U.S.S.R., Vol. 11, pp. 177–192, 1947.*) *U.S., Air Force, Technical Report No. F-TS-1209-IA*, January, 1949. 31 pp., figs. 5 references.

Simplification of the problems of one-dimensional flow by a transformation of the equations of gas dynamics. The transformed equations are applied to flow without friction in a cylindrical pipe; the case of an abrupt widening of the cylindrical pipe, the flow without friction and heat exchange in a pipe with a diaphragm having a tapering opening, and the determination of the gas reaction upon a channel with a rectilinear axis. Application of the transformed equations to the design of an ejector is detailed. In this, S. A. Christianovich's theory and method for design of a gas ejector is extended to cases of gas mixtures having different initial temperatures.

Formation of Envelopes of Curved Mach Waves in Flow Along a Convex Wall. M. Schaefer. (*Dresden, Technische Hochschule, 1944. Peenemünde Archiv 44/12a.*) *U.S., Air Force, Technical Report No. F-TS-1203-IA*, January, 1949. 44 pp., figs. 2 references.

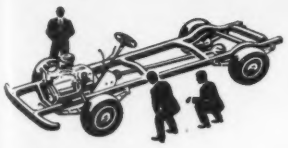
A continuation of an investigation of differential gas dynamics. The necessity for the formation of an envelope of Mach waves can be eliminated by transition to the general case of a flow field in which both families of Mach waves are curved. Compression occurs on a convex wall with decreasing curvature. The converging tendency of the Mach waves caused by compression eventually overcomes the diverging tendency due to curvature. By an analytical calculation of the flow problem in the neighborhood of the point of origin of the envelope, the disadvantage of the method of characteristics is overcome and that method can be fitted into the solution.

On the Subsonic Flow Through Circular and Straight Lattices of Airfoils. C. C. Lin. *Journal of Mathematics and Physics*, Vol. 28, No. 2, July, 1949, pp. 117–130, figs. 3 references.

A slight generalization of the hodograph method to permit its application to flows through multiple connected regions. The inverse method of generating such flows that is evolved, is general in that the final results involve an arbitrary function that may be used to take care of the shape of the airfoils comprising the lattice. The mapping problem and the flow problem are entirely separated. By examining the most general functions for the conformal mapping of a circle into a straight lattice of identical airfoils the essential parts of the nature of the junction can be seen and the generalization to the circular lattice of a finite number of airfoils can be accomplished.

The Flow of a Supersonic Jet From a Vessel With Plane Walls. F. I. Frankl. (*U.S.S.R., Academy of Sciences, Transactions, Vol. 58, No. 3, 1947.*) *U.S., Air Force, Technical Report No. F-TS-1213-IA*, May, 1949. 7 pp., figs. 6 references.

The boundary-value problem is reduced in the hodograph plane to a special case of the Tricomi problem. In the limiting case considered by Chaplygin, the curve of the critical velocity coincides with the boundary of the jet. In this case, however, it intersects the boundary of the jet in two places. The value of the flux coefficient for a jet of critical velocity is thus determined to be larger than the value given by Chaplygin.



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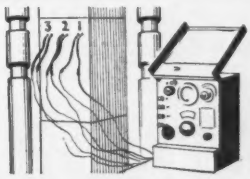

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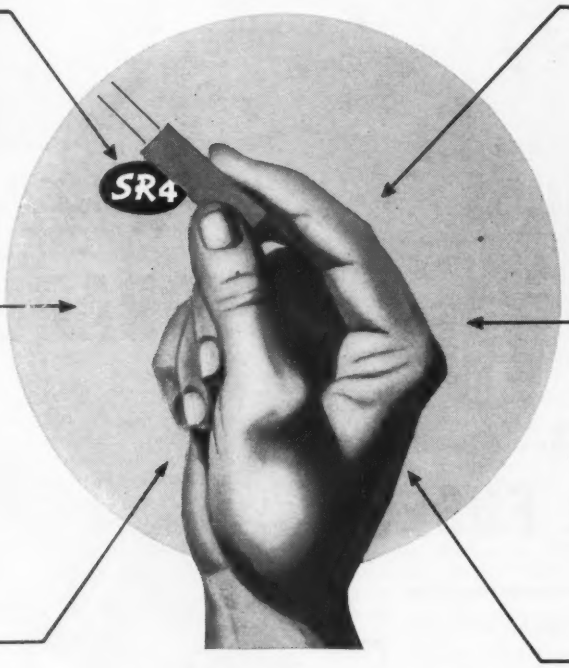

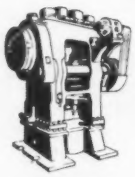

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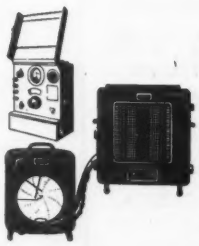

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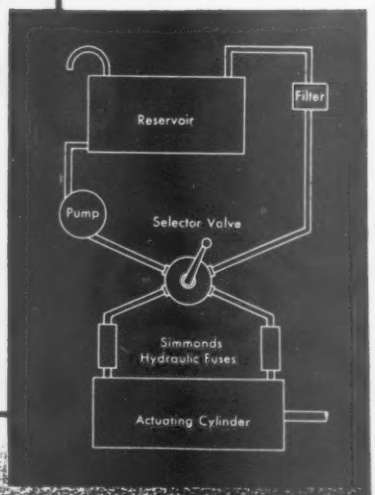

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Downwash and Sidewash Behind a Thin Delta Wing in Compressible Subsonic Flow. R. J. Gunkel. *Douglas Aircraft Company, Inc., Report No. SM-13326,* August 9, 1948. 20 pp., figs. 3 references.

The downwash and sidewash in the Trefftz Plane behind a thin delta wing in compressible subsonic flow are investigated on the basis of linearized theory. Formulas for the downwash and the sidewash for this special case are given in closed form and compared to the similar formulas of Reference 1, which treats the same problem for supersonic flow. The spanwise variation of the downwash and sidewash functions is given in graphical form for various distances above the plane of the wing in the Trefftz Plane.

The Head Shock Wave. M. M. Munk and J. Conrad Crown. *U.S., Naval Ordnance Laboratory, Memorandum No. 9773,* August 25, 1948. 16 pp., diagrs., figs.

A uniform stream of perfect air impinging with supersonic velocity upon a semi-infinite body of finally constant width may give rise to only one shock wave. The theoretical drag of the body can then be deduced from the shape of this head shock wave. The drag associated with more than one shock wave exceeds the drag computed from the head shock wave. The relation between the wave shape and the drag is deduced and discussed in this memorandum.

Approximate Pressure Distribution Calculations for Slender Bodies of Revolution in Axial Supersonic Flow. Ernest W. Graham. *Douglas Aircraft Company, Inc., Report No. SM-13270,* May 4, 1948. 25 pp., diagrs. 3 references.

A simple method that requires the approximation of the body shape by a series of simple elements. In each element the second derivative of cross-sectional area with respect to length must be constant. The contribution of each element to the pressure at any downstream point reduces to a function of the shape of the element and its distance from the point. The resultant pressure at a given point is the sum of the contributions of all the elements preceding that point. To illustrate the use of this method three examples of increasing complexity are presented: an approximately parabolic body, a cylinder followed by a cone, and a body of arbitrary shape. The accuracy of this method is estimated as roughly within —15 per cent on drag coefficient. A problem similar to the most complex one considered here should require approximately 2 man days for calculations. In many cases no more accuracy than this is justified since other factors in the problem are not known to better accuracy.

Report on Investigation of Developed Turbulence. L. Prandtl. (*Zeitschrift für angewandte Mathematik und Mechanik, Vol. 5, No. 2, April, 1925,* pp. 136–139.) *U.S., N.A.C.A., Technical Memorandum No. 1231,* September 19, 1949. 7 pp., figs. 3 references.

Assumptions leading to the empirical Blasius law for the resistance of smooth pipes to fluid flow are generalized and expressed in such a way as to furnish a velocity distribution for any empirical resistance law. The method thus becomes applicable to arbitrarily high Reynolds Numbers. The concept of the mixing length is introduced in connection with the Boussinesq formula for turbulent shear.

Scie Piane Turbolente (Turbulent Two-Dimensional Wakes). G. Moretti. (*L'Aerotecnica, Vol. 27, Fasc. 3, 1947, pp. 210–221 figs. 4 references.*) *Turin, Politecnico, Laboratorio di Aeronautica, Pubblicazione No. 206.* 12 pp. (Reprint.) (In Italian.)

A general expression for the tangential stress appearing in the two-dimensional theory of turbulent motion is applied to the investigation of the wake past a simple and a double cylindrical object. Comparison of the first and second approximation of the total head with experimental values shows the formula used to be more satisfactory than that of Prandtl because it contains less arbitrary elements and thus can be better adapted to the experimental results than formulas derived from transport theories.

On the Theory of Oscillating Airfoils of Finite Span in Subsonic Compressible Flow. Eric Reissner. *U.S., N.A.C.A., Technical Note No. 1953,* September, 1949. 37 pp. 6 references.

The problem of the oscillating lifting surface of finite span in subsonic compressible flow is reduced to an integral equation, which is approximated by a simpler expression, on the basis of the assumption of sufficiently large aspect ratio. Thus the double integral occurring in the formulation of the problem is reduced to two single integrals, one of which is taken over the chord and the other over the span of the lifting surface. By this reduction the three-dimensional problem appears separated into two two-dimensional problems, one being effectively the problem of two-dimensional flow and the other the problem of spanwise-circulation distribution.

Attainable Circulation of Airfoils in Cascade. Arthur W. Goldstein and Artur Mager. *U.S., N.A.C.A., Technical Note No. 1941,* September, 1949. 59 pp., figs. 13 references.

From consideration of available information on boundary-layer behavior, a relation among profile thickness, maximum surface velocity, Reynolds Number, velocity diagram, and solidity is established for a cascade of airfoils immersed in a two-dimensional incompressible fluid flow. Several cascades are computed to show the effect of various cascade design parameters on minimum required cascade solidity.

On a New Method in the Theory of Compressible Fluid. Chi-Teh Wang. *Chinese Institute of Engineers, American Section, Journal,* Vol. 6, 7, Nos. 1, 2, May, 1949, pp. 89–111, figs. 13 references.

A new method is worked out in this paper for the approximate solution of a compressible flow passing an arbitrary airfoil. The method used is the so-called variational method. This method has the advantage of being a direct method whereby one may be able to calculate the compressible flow passing a given airfoil at different Mach Numbers. Computation can also be made to obtain a solution of higher accuracy without introducing any additional mathematical difficulty. A numerical example has been carried out and the results check excellently with those found by existing methods.

Anwendungen der Elektrolytischen Methode auf die Betzishem Theorie der Spaltverluste an Schaufelgittern (The Use of the Electrolytic Method with the Betz Theory of Clearance Losses in Bucket Grids). Mahmoud Ali Hassan. *Zürich, Eidgenössische Technische Hochschule, Institut für Aerodynamik, Mitteilungen Nr. 15,* 1949. 73 pp., illus., diagrs., figs. 16 references. Verlag Leemann, Zürich. 9 Swiss Fr. (In German.)

An electrolytic analogy was used to solve a simple case, the parallel frictionless flow about a rectangular body, in order to establish the accuracy of the method. After the potential flow on the walls of a bucket lattice with radial flow had been obtained by numerical methods, the problem was handled by the electrolytic method to obtain further verification of its accuracy. The electrolytic method was then used alone for selected cases of bucket-grid clearance losses between extreme cases susceptible of solution by airfoil theory as carried out by A. Betz.

Pressure Distributions From Theoretical Approximations of the Flow Pattern. John S. McNown and En-Yun Hsu. *Heat Transfer and Fluid Mechanics Institute, University of California, Berkeley, Calif.,* June 22–24, 1949, pp. 65–76, figs. 10 references. American Society of Mechanical Engineers, New York. $5.00.

Axial Flow Ducted Fan Theory. D. B. Welbourn. *The Engineer,* Vol. 188, No. 4878, July 22, 1949, pp. 86, 87, figs.

The Pressure on a Slender Body of Non-Uniform Cross-Sectional Shape in Axial Supersonic Flow. Ernest W. Graham. *Douglas Aircraft Company, Inc., Report No. 167,* August, 1948. 27 pp., diagrs., figs.

The Pressure on Slender Bodies of Uniform Cross-Sectional Shape in Axial Supersonic Flow Preliminary. Ernest W. Graham. *Douglas Aircraft Company, Inc., Report No. SM-13377,* August 18, 1948. 16 pp., figs. 1 reference.

Pressure and Drag on Smooth Slender Bodies in Linearized Flow. Ernest W. Graham. *Douglas Aircraft Company, Inc., Report No. SM-13417,* April 20, 1949. 10 pp., figs. 3 references.

Formulas in Three-Dimensional Wing Theory. I. *Douglas Aircraft Company, Inc., Report No. SM-11901,* July 8, 1946. 53 pp., diagrs., fig.

The Impact Tube in a Viscous Compressible Gas. T. L. Chambré and H. R. Smith. *Heat Transfer and Fluid Mechanics Institute, University of California, Berkeley, Calif.,* June 22–24, 1949, pp. 271–278, diagrs. 9 references. American Society of Mechanical Engineers, New York. $5.00.

Plane Parallel Gas Flow Past an Ellipse. L. K. Kudriashov. (*Prikladnaia Matematika i Mekhanika, U.S.S.R., Vol. 11, 1947, pp. 119–128.*) *U.S., Air Force, Technical Report No. F-TS-1208-1A,* January, 1949. 20 pp., fig. 4 references.

The Appearance of a Compression Shock in the Neighborhood of a Convex Wall Surface Which is Free from Singularities. M. Schaefer. (*Dresden, Technische Hochschule, Archiv 44/12b,*

1944.) *U.S., Air Force, Technical Report No. F-TS-1206-IA,* January, 1949. 22 pp., figs.

Asymptotic Resolution of Chaplygin's Functions. F. I. Frankl. (*U.S.S.R., Academy of Sciences, Transactions, Vol. 58, No. 5, 1947.*) *U.S., Air Force, Technical Report No. F-TS-1212-IA,* May, 1949. 7 pp. 4 references.

Plane Motion of a Gas at Hypersonic Velocity. S. V. Falkovich. (*Prikladnaia Matematika i Mekhanika, U.S.S.R., Vol. 11, 1947, pp. 459-464.*) *U.S., Air Force, Technical Report No. F-TS-1221-IA,* May, 1949. 11 pp.

Summary of Characteristic Methods for Steady State Supersonic Flows. H. W. Liepmann and Ellis Lapin. *Douglas Aircraft Company, Inc., Report No. SM-13343,* May 31, 1949. 33 pp., diagrs., figs. 3 references.

Pressure Distribution of a Cylinder Preceded by a Cone in Axial Supersonic Flow (Linearized Theory, Slender Bodies). Ernest W. Graham. *Douglas Aircraft Company, Inc., Report No. SM-13322,* July 21, 1948. 8 pp., figs. 1 reference.

Note sur une Méthode de Tracé D'Écoulements Supersoniques à Deux Dimensions (A Note on a Method of Representing Two-Dimensional Supersonic Flows). Jacques Nicolas. *France, Office National d'Études et de Recherches Aéronautiques, Publication No. 12,* 1948. 13 pp., figs. (In French.)

Tableaux de Calculs et Diagrammes Relatifs aux Ondes de Choc Obliques en Écoulements Bi-Dimensionnels (Tables of Calculations and Diagrams for Oblique Shock Waves in Two-Dimensional Flows). J. Nicolas and H. Audic. *France, Office National d'Études et de Recherches Aéronautiques, Publication No. 11,* 1948. 19 pp., figs. (In French.)

Contribution à L'Étude des Écoulements Supersoniques à Deux Dimensions; Méthode Graphique de Tracé d'Ecoulements Comportant des Ondes de Choc et des Détentes (Contribution to the Study of Supersonic Two-Dimensional Flows; A Graphic Method of Representing Flows with Shock and Expansion Waves). Louis Viaud. *France, Office National d'Études et de Recherches Aéronautiques, Publication No. 13,* 1948. 21 pp., figs. 3 references. (In French.)

Essai d'une Théorie sur la Résistance d'un Profil en Fluide Naturel, Compressible, aux Vitesses Soniques (An Essay on the Theory of the Resistance of a Profile in a Compressible Natural Fluid at Sonic Velocity). M. Risack. *Belgium, L'Académie Royale, Bulletin du Service Technique de l'Aéronautique, No. 21,* October, 1948. 25 pp., figs. (In French.)

Analyse Dimensionnelle Applications à la Mécanique des Fluides (The Application of Dimensional Analysis to Fluid Mechanics). André Martinot-Lagarde. *France, Office National D'Études et de Recherches Aéronautiques, Rapport Technique No. 31,* October, 1948, figs. 178 references. (In French.)

INTERNAL FLOW

Investigation of Flow Coefficient of Circular, Square, and Elliptical Orifices at High Pressure Ratios. Edmund E. Callaghan and Dean T. Bowden. *U.S., N.A.C.A., Technical Note No. 1947,* September, 1949. 25 pp., diagr., figs. 6 references.

An experimental investigation was conducted to determine orifice coefficients of a jet directed perpendicularly to an air stream as a function of pressure ratio and jet Reynolds Number for elliptical, square, and circular orifices. Effect of air-stream velocity on jet flow was determined for three tunnel-air velocities. Equations for flow coefficient in terms of jet Reynolds Number and pressure ratio were obtained for various shapes. Excellent correlation was obtained between results for jet discharging into still air and results for jet discharging into moving air stream, provided that correct outlet pressure was used.

Mixing, Diffusion, and Pressure Recovery in the Ejector Jet. S. M. Yen, G. L. Armstrong, and R. W. McCloy. *University of Illinois, Institute of Aeronautics, Urbana, Ill., Report No. 9-6,* 1949. 79 pp., diagrs., figs. 8 references.

An analysis at various air-fuel ratios, altitudes and Mach Numbers showed that pressure recovery is a function of the irreversiblity of the mixing and diffusion processes. Mixing should take place at increasing pressure in order to minimize the entropy increase, and thereby to increase the jet-pump efficiency. Pressure recovery during mixing must occur in a mixing chamber of such area variation that there will be no stagnation of the unmixed air or of the mixture, otherwise the mass flow will be limited and eddy losses due to flow reversal will reduce the pressure recovery. A variable-area actuating nozzle is desirable in order to prevent nozzle exit shocks, and a variable area at the throat section is necessary to allow for the increased flow resulting from increasing flight Mach Numbers. With jet-pump efficiencies that should be within reach, pressure ratios greater than unity can be obtained without a compressor or ram. Therefore, by use of vaporized fuel as an ejector pump, the ram jet can be operated without ram.

Stability of Two-Dimensional Velocity Distributions of the Half-Jet Type. Monograph VI; Supplement 1. P. Chiarulli. *U.S., Air Force, Technical Report No. F-TS-1228-IA,* June, 1949. 51 pp., figs. 27 references.

A study of half-jet velocity distributions in which the velocity distribution, a function of y, increases monotonically, and the range of y is from $-\infty$ to $+\infty$. The velocity distribution approaches a finite constant value as y approaches $\pm\infty$. Only the two "inviscid" asymptotic solutions of the disturbance differential equation appear in the boundary value problem. Results that are valid for viscous fluids are obtained, however, by including the second approximations of these "inviscid" solutions. The eigenvalue equation is obtained in closed form and the calculation of the eigenvalues is reduced to the straightforward evaluation of definite integrals. There is only one nontrivial, neutral solution of the eigenvalue equation for the velocity of propagation of the disturbance is equal to the value of the velocity distribution at its point of inflection and an expression is obtained for the wave number of the disturbance. Stability considerations are carried out for the case of the half-jet where one of the two flows is stationary. The eigenvalue solutions for the inviscid case are in close agreement with the calculations of Lessen.

The Effect of Wall Friction on the Strength of Shock Waves in Tubes and Hydraulic Jumps in Channels. Coleman duP. Donaldson and Roger D. Sullivan. *U.S., N.A.C.A., Technical Note No. 1942,* September, 1949. 36 pp., illus., diagrs., figs. 6 references.

A theory is presented for the attenuation due to viscous boundary layer of shock waves traveling in closed passages. Because of the similar nature of the problem, the theory is also developed for the attenuation of a hydraulic jump moving in a channel. The results of experiments that bear out the theory are presented for both a shock tube and a hydraulic channel.

Method of Increasing Fluid Stream by Diverting It From Its Axis of Flow; Coanda Effect. A. R. Metral. (*Ministere de l'Air, Cabinet Technique, November, 1938.*) *U.S., Air Force, Translation No. F-TS-823-RE,* February, 1948. 58 pp., figs.

A compressible or incompressible flow is ejected at high speed from a slot. It is stated that if one side of orifice is developed into one-half of a divergent trough, stream is deflected from axis of flow and follows slope of divergent wall, thereby increasing in velocity and mass by entraining additional air. Possible applications of idea discussed, particularly for silencers in internal combustion engines.

Design Method for Two-Dimensional Channels for Compressible Flow With Application to High-Solidity Cascades. Sumner Alpert. *U.S., N.A.C.A., Technical Note No. 1931,* August, 1949. 33 pp., figs. 6 references.

A procedure for design of two-dimensional channels for compressible nonviscous flow. The method requires boundary conditions consisting of the shape of one channel surface and the velocity distribution on that surface. The process consists of the step-by-step computation of an arbitrary number of streamlines within the channel.

Mixing of Parallel Flowing Streams in a Pressure Gradient. C. K. Ferguson. *Heat Transfer and Fluid Mechanics Institute, University of California, Berkeley, Calif.,* June 22-24, 1949, pp. 77-88, diagrs., figs. 7 references. American Society of Mechanical Engineers, New York. $5.00.

A Study of Freely Expanding Inhomogeneous Jets. W. R. Keagy and A. E. Weller. *Heat Transfer and Fluid Mechanics Institute, University of California, Berkeley, Calif.,* June 22-24, 1949, pp. 89-98, diagr., figs. 3 references. American Society of Mechanical Engineers, New York. $5.00.

Loss Coefficients for Abrupt Changes in Flow Cross Section With Low Reynolds Number Flow in Multiple Tube Systems. William M. Kays. *Heat Transfer and Fluid Mechanics Institute, University of California, Berkeley, Calif.,* June 22-24, 1949, pp. 99-112, illus., figs. 9 references. American Society of Mechanical Engineers, New York. $5.00.

Report of Progress on Measurements of Friction Coefficients, Recovery Factors, and Heat Transfer Coefficients for Supersonic

Flow of Air in a Pipe. Joseph Kaye, Joseph H. Keenan, and William H. McAdams. *Heat Transfer and Fluid Mechanics Institute, University of California, Berkeley, Calif.*, June 22–24, 1949, pp. 147–163, diagrs., figs. 11 references.

Co-Current Gas-Liquid Flow. I—Flow in Horizontal Tubes. Olaf P. Bergelin and Carl Gazley, Jr. *Heat Transfer and Fluid Mechanics Institute, University of California, Berkeley, Calif.*, June 22–24, 1949, pp. 5–18, illus., figs. 19 references. American Society of Mechanical Engineers, New York. $5.00.

Co-Current Gas-Liquid Flow. II—Flow in Vertical Tubes. O. P. Bergelin, P. K. Kegel, F. G. Carpenter, and Carl Gazley, Jr. *Heat Transfer and Fluid Mechanics Institute, University of California, Berkeley, Calif.*, June 22–24, 1949, pp. 19–28, diagrs., figs. 7 references. American Society of Mechanical Engineers, New York. $5.00.

Co-Current Gas-Liquid Flow. III—Interfacial Shear and Stability. Carl Gazley, Jr. *Heat Transfer and Fluid Mechanics Institute, University of California, Berkeley, Calif.*, June 22–24 1949, pp. 29–40, figs. 30 references. American Society of Mechanical Engineers, New York. $5.00.

An Analysis of Short Length Liquid Sprays. Martin B. Biles. *Heat Transfer and Fluid Mechanics Institute, University of California, Berkeley, Calif.*, June 22–24, 1949, pp. 41–50, figs. 6 references. American Society of Mechanical Engineers, New York. $5.00.

On Two-Dimensional Non-Steady Motion of a Slender Body in a Compressible Fluid. C. C. Lin, E. Reissner, and H. S. Tsien. *Journal of Mathematics and Physics*, Vol. 27, No. 3, October, 1948, pp. 220–231. 4 references.

PARASITIC COMPONENTS & INTERFERENCE

Some Linearized Computations of Supersonic Wing-Tail Interference. Martha E. Graham. *Douglas Aircraft Company, Inc., Report No. SM-13430*, December 23, 1948. 54 pp., figs. 12 references.

An investigation of the effects of wing-tail interference upon the longitudinal stability of a tandem-delta-wing missile at supersonic speeds. The missile is assumed to have a configuration with no body but only a rigid line connecting wing and tail; both the wing and tail lie in the same plane. First the induced flow field downstream of the wing is studied; then the effect of this flow field on the lift and center of pressure of the tail is determined. This required a preliminary study of possible corrections to linearized downwash theory to take some account of the deflection and warping of the vortex sheet; the two different assumptions of an unwarped, deflected vortex sheet and of two deflected vortex lines are made. It also required an examination of the concept of apparent angle of attack and the properties of certain elementary lifting strips. Equations are developed and graphs presented giving lift and center of pressure versus angle of attack with parameters defining the geometry and Mach Number of the configuration. The most significant result appears to be the nonlinearity of the curves for center of pressure of the wing-tail combination. Numerical values of the tail lift coefficient and the variation of this coefficient with Mach Number are found to depend very much upon the choice of assumptions concerning the behavior of the vortex sheet, a choice which can be made only from a knowledge of experimental results.

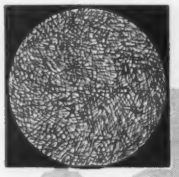
Restoring Moment in Yaw Due to Interference Between the Vertical Stabilizer and Fuselage at Supersonic Velocities. Charles W. Coale. *Douglas Aircraft Company, Inc., Report No. SM-13496*, February 7, 1949. 22 pp., figs.

Wing-body interference methods are used. Upsweep of the body, when present, causes additional interference due to induced circulation around the body. Sidewash in the plane of the fin of a specific fuselage-tail configuration is determined for three types of body cross section. For an unswept body the interference sideforce on the tail is found to be approximately 30 per cent of that due to the tail alone. With upsweep of the body included, this value is increased to 40–60 per cent.

General Considerations About Planar and Non-Planar Lifting Systems. P. A. Lagerstrom and M. D. Van Dyke. *Douglas Aircraft Company, Inc., Report No. SM-13432*, June, 1949. 80 pp., diagrs., figs. 30 references.

Interference Between Wing and Body at Supersonic Speeds. I. Carlo Ferrari. *Cornell Aeronautical Laboratory, Inc., Translation*, March 4, 1947. 36 pp., figs. 8 references.

The supersonic flow past a body of revolution with pointed nose and carrying a wing is treated. The flow at infinity is uniform,



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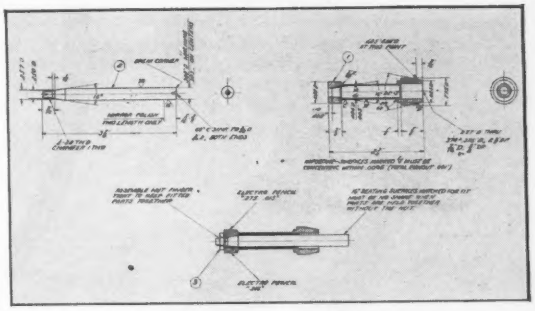

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at a small angle of attack with respect to both the axis of the body and the chord of the wing, and parallel to the plane of symmetry of the body-wing combination. The wing profile is assumed to be that of a flat plate. All perturbations on the uniform stream are assumed to be so small that it is legitimate to linearize the equation of motion. The following are determined: Interference of the wing on the streamlined body, assuming that the induced field generated by the wing is that which would exist around the wing if it were placed in the uniform stream alone; and interference of the body on the wing, neglecting the distortion of the field around the body due to the presence of the wing.

PERFORMANCE

An Analysis of the Effect of Lift-Drag Ratio and Stalling Speed on Landing-Flare Characteristics. J. Calvin Lovell and Stanley Lipson. *U.S., N.A.C.A., Technical Note No. 1930*, September, 1949. 34 pp., figs. 1 reference.

Results of calculation of the landing-flare paths of a series of hypothetical airplanes having systematically varying characteristics are presented in chart form to show the effect of lift-drag ratio and stalling speed on landing-flare velocities and distance requirements. Results indicate that airplanes landing at low lift-drag ratios will be required to start the landing flare at relatively high altitudes and will have relatively high sinking speeds at the start of the flare and at an altitude of 50 ft. Airplanes having high stalling speeds will require relatively large horizontal distances for either power-on or power-off landing flares.

Analytical Investigation of Lateral Motions of an Airplane at the Stall With and Without Autopilot. G. F. Campbell and Gifford Bull. *Cornell Aeronautical Laboratory, Inc., Report No. TB-556-F-1*, April 7, 1949. 52 pp. 14 references.

WINGS & AIRFOILS

A Solution for the Lift and Drag of Airfoils With Air Inlets and Suction Slots. C. B. Smith. *Journal of the Aeronautical Sciences*, Vol. 16, No. 10, October, 1949, pp. 581-589, figs. 6 references.

The general airfoil theory is extended to cover the case of airfoils having air inlets and suction slots. The analysis, employing formal potential theory, rests on the usual assumptions of an incompressible, nonviscous fluid satisfying the Kutta condition. Subject to these assumptions, the lift and drag of such an airfoil have been found and the results have been confirmed by simple tests. In general, it is indicated that an air inlet or suction slot on the upper surface increases the lift or, on the lower surface, decreases the lift in a manner analogous to changing the camber of the airfoil. An air inlet near the nose is indicated to have no effect on the lift, while a suction slot on the upper surface, or the equivalent of a source on the lower surface near the trailing edge, is indicated to give large lift increments. The latter arrangements are considered to be of possible interest as a control or high lift device. All of these effects are hydrodynamic and independent of the effect of the inlet or slot on the boundary layer.

On the Theory of a Wing of Finite Aspect Ratio in Supersonic Flow. S. V. Falkovich. (*Prikladnaia Matematika i Mekhanika, U.S.S.R., Vol. 11, 1947, pp. 391-394.*) *U.S., Air Force, Technical Report No. F-TS-1215-IA*, May, 1949. 9 pp., figs. 4 references.

A method for determining the velocity potential of gas which is produced by a thin, slightly curved wing moving at supersonic velocity is based on the classical method of Volterra for solving the Cauchy problem of the cylindrical wave equation. The application of this method also makes it possible to determine the velocity potential for the case in which the wing executes small harmonic oscillations at forward velocities near supersonic.

Effect of Aerodynamic Hysteresis on Critical Flutter Speed at Stall. Alexander Mendelson. *U.S., N.A.C.A., Research Memorandum No. E8B04*, June 18, 1948. 24 pp., figs. 8 references.

Turbine and compressor blades are subject to stalling flutter, a type of vibration that is self-sustained by the absorption of energy from the air stream. Stalling flutter may occur on profiles at high angles of attack near the stall point and at much lower critical flutter speeds than would be expected under classical-flutter theory. Calculations show that, at least in some cases, critical stalling flutter can be explained on the basis of an aerodynamic lag or hysteresis effect. The general characteristics of stalling flutter, namely, decreases in critical flutter speed and in effective aerodynamic torsional damping coefficient with increasing angle of attack, were shown to be related to the more fundamental concept of lagging aerodynamic forces and moments. Correlation of the experimental and theoretical results was found possible by assuming that the angle of aerodynamic lag varies as the slope of the static-lift curve. The aerodynamic lag was shown to cause the effective torsional damping to decrease, thereby explaining the low values of torsional aerodynamic damping obtained at stall.

Wing Sections With Minimum Drag at Supersonic Speeds. G. Drougge. *Sweden, Aeronautical Research Institute, Report No. 26*, 1949. 15 pp., figs. 2 references.

Determination of the form of the wing profile section that gives the smallest possible drag coefficient at a zero angle of attack and at supersonic speeds under given conditions of maximum thickness, section area, and moment of inertia with respect to the section chord. All sections are sufficiently slender to permit the use of Ackeret's linearized two-dimensional supersonic theory. In addition to certain optimum section forms that are determined, the double circular arc profile is considered, since that section form is often encountered in discussions of supersonic wing sections.

Note on the Position of the Aerodynamic Center of Pointed Wings at Subsonic Speeds. S. B. Berndt. *Sweden, Royal Institute of Technology, Division of Aeronautics, Technical Note No. KTH—AERO TN 5*, June 30, 1948. 6 pp., figs.

A simple method is suggested for the design of wings whose aerodynamic center is independent of a variation of the lateral dimensions of the wing. The method is applied to tapered wings, and good agreement is found with tests on wings with straight trailing edges, and a taper ratio of 0.303. According to Prandtl-Glauert's rule the position of the aerodynamic center for the wings in consideration is independent of the Mach Number at subsonic speeds.

Three Component Measurement and Flow Investigation of Plane Delta Wings at Low Speeds and Zero Yaw. S. B. Berndt. *Sweden, Royal Institute of Technology, Division of Aeronautics, Technical Note No. KTH—AERO TN 4.* 19 pp., illus., diagrs., figs.

Three component measurements and stream-flow tests at low speeds have been made at zero yaw on six plane delta wings, three of which are triangular and three tapered with taper ratio 0.3. The aspect ratio of the wings is between 0.5 and 2.5. At small angles of attack the experimental values of lift and pitching moment are in agreement with calculations based on linear wing theory. At greater angles of attack a nonlinearity is observed, which rapidly increases with decreasing aspect ratio, and which may be due to a backwards movement of the lift distribution. The separation of the flow begins at the wing tips, and spreads inwards with increasing angle of attack so slowly that even at an angle of attack of 40°, it does not cover the whole wing.

Theoretical Relations Between the Stability Derivatives of a Wing in Direct and in Reverse Supersonic Flow. Sidney M. Harmon. *U.S., N.A.C.A., Technical Note No. 1943*, September, 1949. 47 pp., figs. 10 references.

Contains an investigation by means of the linearized theory to obtain relations between the stability derivatives of a wing and its reverse in supersonic flow. The wings investigated have a supersonic leading edge, a supersonic trailing edge, and either supersonic side edges or subsonic nonre-entrant side edges which are noninteracting. The investigation is made for thin flat-plate wings for steady vertical and longitudinal motions, steady rolling and pitching, and motions in which the wing is accelerating uniformly in the vertical direction.

A Theoretical Survey of Induced Vertical Velocity in Front of an Aircraft Wing. M. M. Callan. *Canada, National Research Council, Aeronautical Note No. AN-5 (N.R.C.1881, MA-209)*, 1949. 15 pp., figs. 1 reference.

The optimum position for mounting an angle of attack indicator on a glider. Calculations for the induced vertical velocity were made in front of wings with rectangular and elliptical loading. Charts for three spanwise stations were compiled. From these charts, contours of nearly constant downwash in regions of small downwash in front of an aircraft can be constructed for any required lift coefficient and aspect ratio. The charts will also give, for different positions of the instrument on the glider, the downwash at the indicator as the angle of attack changes.

Damping-in-Roll Calculations for Slender Swept-Back Wings and Slender Wing-Body Combinations. Harvard Lomax and

Max. A. Heaslet. *U.S., N.A.C.A., Technical Note No. 1950,* September, 1949. 32 pp., figs. 8 references.

Effect of Linear Symmetric Twist on Drag of Rectangular Wing in Supersonic Flow. Martha E. Graham. *Douglas Aircraft Company, Inc., Report No. SM-13303,* June 21, 1948. 15 pp., diagrs. 2 references.

By means of nonviscous linearized supersonic theory the effect of linear symmetric twist upon the drag of a rectangular wing is studied. For this particular case it is found that the drag due to twist is determined by the Mach Number and the geometry of the wing and is independent of the attitude or total lift. The results are presented in equations and in two graphs. Graph 1 gives the drag of a rectangular wing with no thickness but with twist at zero lift. Graph 2 gives the drag due to both thickness and twist of a rectangular wing of symmetric double-wedge (diamond) profile. It is found that the drag coefficient introduced by twist is small, for example, about 0.0005 for a wing of aspect ratio 4 with 3° of twist at a Mach Number 2. This is equivalent to the additional thickness drag obtained by increasing the thickness of a diamond profile from 5 per cent to about 5.13 per cent.

Downwash and Sidewash Induced by Three-Dimensional Lifting Wings in Supersonic Flow. P. A. Lagerstrom, Martha E. Graham, and G. Grosslight. *Douglas Aircraft Company, Inc., Report No. SM-13007,* April 14, 1947. 76 pp., figs. 5 references.

A study using linearized theory of the induced flow field behind a three-dimensional supersonic wing in order to obtain formulas for the downwash which such a lifting surface induces in the neighborhood of other parts of an airplane or missile. Expressions are also obtained for the sidewash induced by a lifting surface in order to make possible stability calculations for designs in which wing and control surfaces are not parallel. The relevant results of the conical flow theory of A. Busemann are given without derivation and only elementary mathematical technique is used except in one section which employs the functions of complex variables. The rectangular wing and the trapezoidal wing whose side edges have been cut along the Mach cones from the tips are treated in detail. Complete expressions for the values at the trailing edge and at infinity have been evaluated for the general trapezoidal wing and for specific triangular wings.

Method of Designing Airfoils With Prescribed Velocity Distributions in Compressible Potential Flows. George R. Costello. *U. S., N.A.C.A., Technical Note No. 1913,* August, 1949. 25 pp., figs. 8 references.

By the assumption that the pressure-volume relation is linear, a method is given for computing the airfoil shape with a prescribed velocity distribution in a potential flow of a compressible nonviscous fluid.

The Effects of Sideslip, Aspect Ratio, and Mach Number on the Lift and Pitching Moment of Triangular, Trapezoidal, and Related Plan Forms in Supersonic Flow. Arthur L. Jones, Robert M. Sorenson, and Elizabeth E. Lindler. *U. S., N.A.C.A., Technical Note No. 1916,* August, 1949. 69 pp., figs. 8 references.

The variations of lift and pitching moment with sideslip in supersonic flow have been calculated for a representative group of plan forms. The variations of lift and pitching moment with aspect ratio and Mach Number at zero sideslip were also investigated. The analysis was based on linearized potential theory and was applied to triangular, trapezoidal, rectangular, and sweptback plan forms without dihedral.

A Flight Determination of the Tolerable Range of Effective Dihedral on a Conventional Fighter Airplane. Charles J. Liddell, Jr., Rudolph D. Van Dyke, Jr., and Donovan R. Heinle. *U.S., N.A.C.A., Technical Note No. 1936,* August, 1949. 25 pp., illus., diagrs., figs. 3 references.

A conventional fighter airplane was equipped with a special device for varying the effective dihedral in flight. A survey of pilots' opinions was made to determine which values of effective dihedral were intolerable. The relation between the findings and the present Air Force-Navy stability and control specifications is discussed.

The Aerodynamic Derivatives With Respect to Rate of Yaw for a Delta Wing With Small Dihedral at Supersonic Speeds. J. H. Hunter-Tod. *College of Aeronautics, Cranfield, England, Report No. 28,* March, 1949. 20 pp., figs. 5 references.

Remarks on the Triangular Wing in Supersonic Flow. M. I. Gurevich. (*Prikladnaia Matematika i Mekhanika, U.S.S.R., Vol. 11, 1947, pp. 297–300.*) *U.S., Air Force, Technical Report No. F-TS-1214-IA,* May, 1949. 10 pp., figs. 5 references.

Summary Report on the High-Speed Characteristics of Six Model Wings Having NACA 65-Series Sections. William T. Hamilton and Warren H. Nelson. *U.S., N.A.C.A., Report No. 877,* 1947. 17 pp., figs. 3 references. U.S. Govt. Printing Office, Washington. $0.15.

Méthode de Calcul de la Trainée Minimum D'Avions (A Method for Calculating the Minimum Drag of Airfoils). H. Guillemet and P. Guienne. *France, Office National D'Études et de Recherches Aéronautiques, Rapport Technique No. 43,* 1948. 42 pp., figs. 10 references. (In French.)

Remarks on the Wing of Finite Aspect Ratio in Supersonic Flow. L. A. Galin. (*Prikladnaia Matematika i Mekhanika, U.S.S.R., Vol. 11, 1947, pp. 383–386.*) *U.S., Air Force, Technical Report No. F-TS-1218-IA,* May, 1949. 9 pp.

On the Problem of a Thin Triangular Wing Moving With Supersonic Velocity. M. I. Gurevich. (*Prikladnaia Matematika i Mekhanika, U.S.S.R.,* Vol. 11, 1947, pp. 395, 396.) *U.S., Air Force, Technical Report No. F-TS-1216-IA,* May, 1949. 5 pp., figs.

Wind Tunnel Tests of Tapered Wings With Various Amounts of Dihedral and Sweepback. O. Holme. (*Sweden, Aeronautical Research Institute, Report No. 17, December, 1945.*) *Royal Swedish Air Board, Translation No. 7,* 1948. 24 pp., diagrs., figs. 5 references. (In English.)

Some Aerodynamic Formulas in Linearized Supersonic Theory for Damping in Roll and Effect of Twist for Trapezoidal Wings. P. A. Lagerstrom and Martha E. Graham. *Douglas Aircraft Company, Inc., Report No. SM-13200,* March 12, 1948. 43 pp., figs. 5 references.

Air Transportation (41)

Pattern for Development of Air Freight Between the United States and Countries in the Caribbean Area. Guy R. Cassell and R. W. Hoecker. *University of Maryland, Agricultural Experiment Station, Miscellaneous Publication No. 77,* November, 1948. 49 pp., tables.

A survey of trade potentials that can be developed through air transport between the United States and the countries of Central America and the West Indies. Markets are indicated in the United States for flowers, fruits, vegetables, fish, drugs, textiles, toys, and other products of skilled hand labor, while machinery, wearing apparel and other manufactured products are in growing demand in the Caribbean area. The report contains statistics of exports and imports, trade regulations, transportation costs, and descriptions of air-transport facilities.

Un Aperçu sur l'Aviation en U.S.S.R. (An Estimate of Aviation in the U.S.S.R.). André Charriou. *L'Air,* Vol. 29, No. 621, November, 1948, p. 1, illus.

Come, Be an Airline Captain. Hy Sheridan. *Flying,* Vol. 45, No. 3, September, 1949, pp. 36, 37, 50, 52, 54, 55, illus.

Replacing the Rapide (de Havilland D.H. 89); A Critical Examination of Requirements for Particular British Internal Routes: The Ideal Specification. *Flight,* Vol. 56, No. 2120, August 11, 1949, pp. 159, 160.

Franco Sold on Air Power Builds Aviation Industry. William Green. *Canadian Aviation,* Vol. 22, No. 8, August, 1949, pp. 28, 29, 64, illus.

Markets for Airborne Seafoods. VII. Spencer A. Larsen, William Reitz, and Katherine K. Burgum. *Air Transportation,* Vol. 15, No. 2, August, 1949, pp. 32, 42.

Donkey to Dakota; What Air Travel Means to the People of Greece. A. E. G. Rumbelow. *Flight,* Vol. 56, No. 2117, July 21, 1949, pp. 81, 82, illus.

Motaircargo. John H. Frederick. *Distribution Age,* Vol. 48, No. 8, August, 1949, pp. 14, 15, 28, illus.

Aerocarriage; A Strategic Air Route. *Aeronautics,* Vol. 21, No. 3, August, 1949, pp. 69, 70.

Airplane Design & Description (10)

Evoluzione delle Strutture Aeronautiche (The Evolution of Aircraft Structures). L. Lazzarino. (*L'Aerotecnica, Vol. 28, Fasc. 1, 1948, pp. 22–32, illus. 45 references.*) *Italy, Universita di Pisa, Facolta di Ingegneria, Pubblicazione No. 531.* 12 pp. (Includes English Summary.) (Reprint.)

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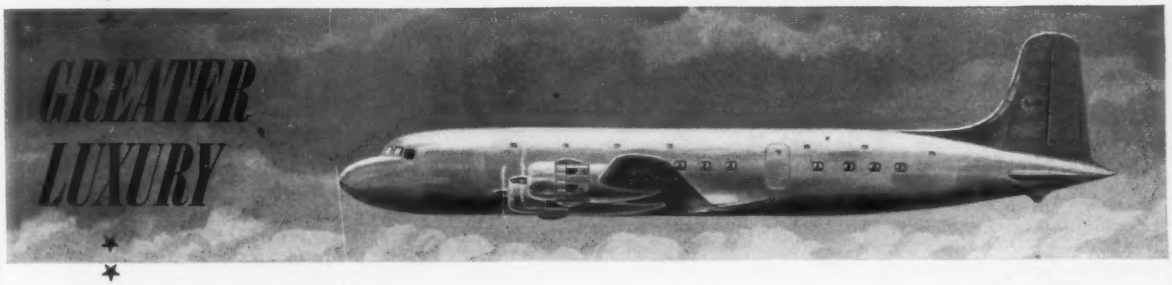

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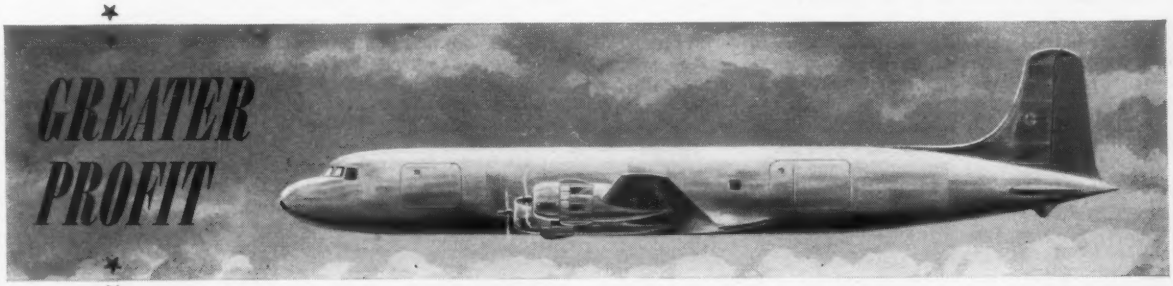
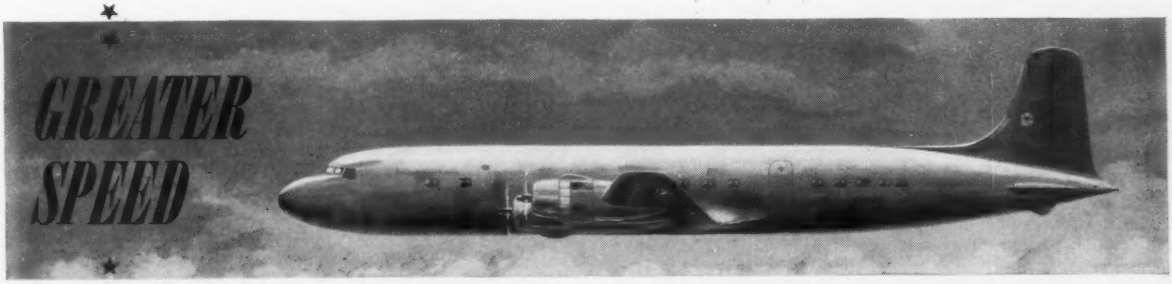


DC-6A *NEW "LIFTMASTER" CARGO TRANSPORT* opens new era in the rapidly expanding air cargo field. Currently being exhibited to airline officials, the "Liftmaster" is the first four-engine cargo airplane specifically designed to fill the need for a modern, medium-size cargo airplane for military and civilian use. In contrast to the Douglas DC-4/C-54, the new DC-6A carries ⅓ *more* cargo at ⅓ *less* cost. The DC-6A flies 100 mph faster than the DC-4/C-54—thus making possible overnight transcontinental cargo service.



DC-6B *THE NEW DC-6B* will be the most versatile air transport ever designed. Like the "Liftmaster," it will be 5 feet longer forward of the wing than the DC-6 and will thus accommodate 8 additional passengers in DC-6 luxury. High density models will carry up to 92 passengers. The over-ocean DC-6B with large galley, coatrooms and lounge will carry 54 passengers in air-conditioned comfort. The 9600 hp developed by the Douglas DC-6B engines will make this the *fastest* non-jet luxury air transport in service.

DOUGLAS

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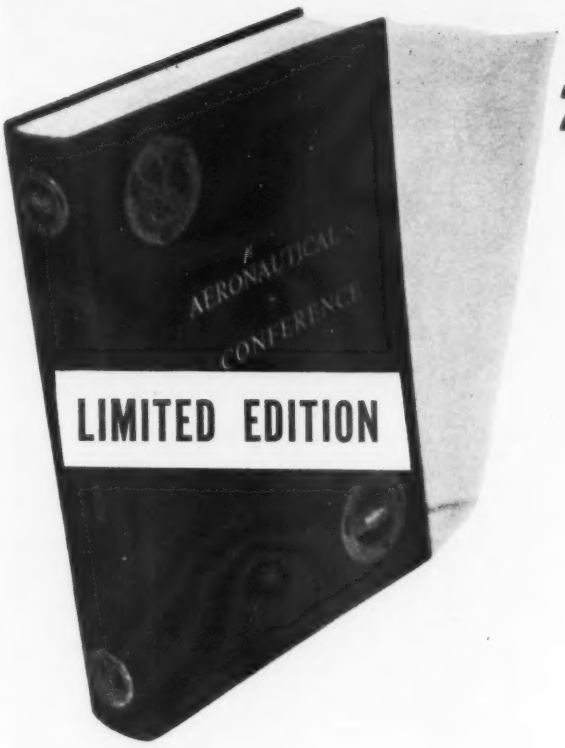
Some Aspects of Convertible Aircraft Design. Robert L. Lichten. *Journal of the Aeronautical Sciences*, Vol. 16, No. 10, October, 1949, pp. 611–622, diagrs., figs. 9 references.

Calculations for a typical case indicate that no unusual or undesirable rotor behavior occurs upon conversion from helicopter-rotor to propeller operation, and blade flapping decreases progressively. The rotor operates efficiently throughout, indicating that aircraft performance is not impaired during the conversion interval. Satisfactory propulsive efficiency can be obtained with isolated rotors having relatively low solidity and blade twist compared to conventional propellers. Good efficiency at high forward speeds requires rotor operation at high pitch and power coefficient, entailing considerable reduction of tip speeds, upon conversion to propeller operation. Model-test data show reasonably accurate results when compared with calculations based on modified vortex theory. The undamped in-plane motion due to gravity excitation of a lag-hinged blade operated with rotor axis horizontal shows negligible hub vibratory loads for a three-bladed rotor, but for a two-bladed unit the amplitude of the vibratory force applied to the hub is considerably greater than the total blade weight, and therefore a semirigid or rigid rotor is required.



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Design of Aircraft Structures for "Mass Production." O. A. Wheelon. *SAE Quarterly Transactions*, Vol. 3, No. 3, July, 1949, pp. 480–489, illus., figs. 1 reference.

Analysis of cost distribution factors leads to a proposal for a cost criterion to relate the suitability of a design to the quantity to be produced. Current trends in materials and properties are causing changes in fabrication techniques that must be recognized. Design producibility is the measure of compatibility of production problems with the facilities and abilities of the organization and entails six fundamental principles: (1) The correct design standpoint must recognize the limitations of the manufacturing facilities, cost estimates being based on a projected quantity with provision for expansion in case of emergency; (2) a production breakdown must be established that is consistent with the projected quantity, the complete installations allowing for inspection within the structural subassemblies; (3) design must be kept within limitations of materials and equipment, employing proved design practices; (4) design of structures and installations must be based on an understanding of normal manufacturing variations rather than on wished-for but unproved methods; (5) established and proved designs must be retained and refined if necessary, rather than redesigned for each new model; and (6) major changes enforced by competition must be preplanned.

"Stratocoach" Spurs Skycoach Study. Stanley L. Colbert. *Aviation Week*, Vol. 51, No. 3, July 18, 1949, p. 55, fig.

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A study was made of an orbiting approach procedure, using Distance Measuring Equipment and the Multiple Track Radar Range. In a large number of flights the same procedure was used by different pilots. The path of the aircraft was continuously recorded in the air. From a detailed analysis of the records the deviations from the nominal path and the variations in time to fly the procedure were ascertained. The merit of the procedure as an aid to air traffic control may be estimated from these results.

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Atomic Energy (48)

Analytical Method for Determing Transmission and Absorption of Time-Dependent Radiation Through Thick Absorbers. I—Radioactivity of Absorber, Time-Dependent. G. Allen *U.S., N.A.C.A., Technical Note No. 1919*, August, 1949. 35 pp. 3 references.

Theoretical analysis of absorbers whose radioactivity is time-dependent. Matrix methods are employed as a tool in analytical determination of intensity of radioactivity and amount of heat generated in any portion of thick absorber. The method is applied to a plane source of monochromatic radiation of single type at normal incidence to a plane absorber, a plane source of polychromatic radiation of single type at normal incidence to plane absorber, and a plane source of polychromatic radiation of several types at normal incidence to plane absorber.

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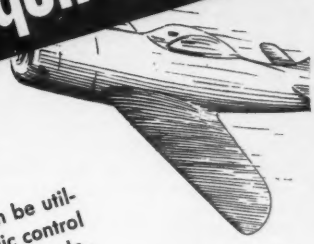
Electrol Hydraulic Devices Are Precision Built to Meet Modern Military Aircraft Requirements



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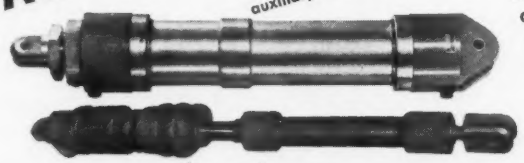

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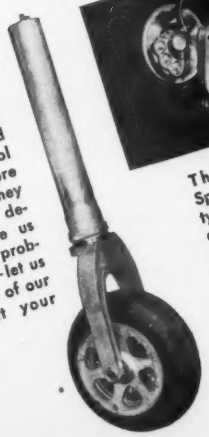

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Education and Training (38)

Air Transport Education. *Interavia*, Vol. 4, No. 8, August, 1949, pp. 494–497, illus.

Discussion of courses and educational facilities available in the United States and Canada through colleges, schools, and company classes, for the teaching of practical and theoretical subjects connected with air transport, ranging from the instruction of reservation clerks and stewardesses to studies of air law.

Electro-Hydraulic Servo Used in Simple Flight Simulators. Schubert. (*Peenemuende, Heeresanstalt, ZWB/86/124, April, 1943.*) *U.S., Air Force, Translation No. F-TS-3102-RE*, March, 1948. 4 pp., figs.

A flight simulator for automatic integration of given differential equations. The construction of simulator with servo units as integrators is mathematically examined. Advantages of servo-operated simulator are that model can be built with available equipment and that directional gyros may be installed for simultaneous tests. Aerodynamic damping and restoring are continuously variable.

Synthetic Training for KLM Pilots. A. Martin-Henry. *Shell Aviation News*, No. 133, July, 1949, pp. 10, 11, illus.

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Contributions to the Theory of Wave Guides. W. Z. Chien, L. Infeld, J. R. Pounder, A. F. Stevenson, and J. L. Synge. *Canadian Journal of Research, Section A, Physical Sciences*, Vol. 27, No. 4, July, 1949, pp. 69–129, figs. 8 references.

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A preliminary report on the theory and application of the Krawinkel image-storage tube. The requirement for indication of high-speed transients in a manner permitting long-term observation is the prime factor which led to the development of the Krawinkel storage tube, which, at present, will record an image occurring in 10^{-8} sec. for periods up to three weeks.

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The Bell Computer, Model VI. E. G. Andrews. *Electrical Engineering*, Vol. 68, No. 9, September, 1949, pp. 751–756, illus., diagrs. 5 references.

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HYDRAULIC & PNEUMATIC (20)

Choice of Operating Pressures for Pneumatic Systems. I. H. F. Gerwig. *Product Engineering*, Vol. 20, No. 8, August, 1949, pp. 127–129, figs.

Considerations involved in the choice of fluid pressures for pneumatic systems, with emphasis on high-pressure systems ranging from 100 to 1,500 and 3,000 psi gage. Fundamental energy and flow relationships for determining speed and size of actuators.

Hydraulic Fluids; Results of Widespread Tests Give Valuable Data but no Definite Answer. *Aviation Week*, Vol. 51, No. 3, July 18, 1949, p. 29.

Flight Operating Problems (31)

CLIMATIZATION

RCAF Probes Artic Effects. Harry Chapin Plummer. *Aero Digest*, Vol. 59, No. 2, August, 1949, pp. 24, 25, 119–122, illus.

Man and Materials in the Polar Regions. George W. Grupp. *United States Naval Institute, Proceedings*, Vol. 75, No. 8, August, 1949, pp. 864–871, illus.

HIGH ALTITUDE FLIGHT

Parachuting From Pressurisation. Charles Gardner. *Aeronautics*, Vol. 21, No. 3, August, 1949, pp. 65, 66.

PILOTING TECHNIQUE

Air Race Piloting Technique. *Aeronautics*, Vol. 21, No. 3, August, 1949, pp. 40, 41, illus.

REFUELING IN FLIGHT

Meteor's 12-Hour Flight; Successful Trial of New Air Refuelling Technique. *Flight*, Vol. 56, No. 2120, August 11, 1949, pp. 177, 178, illus.

Jet Fighter Refueled Via New Technique; Meteor Pilot Maneuvers Nose Probe Into Tanker Hose Cone for Automatic Connection, Breakaway Simple. F. R. Brewster. *Aviation Week*, Vol. 51, No. 9, August 29, 1949, pp. 18–20, illus.

Flight Safety & Rescue (15)

Air-Sea Teamwork; How the Air Force's Air Rescue Service and the U.S. Coast Guard Coordinate Air, Land and Sea Units in Emergencies. Jerry Leichter. *The Pegasus*, Vol. 14, No. 2, August, 1949, pp. 10–13, 16, illus.

Lessons of the Mt. Carmel Crash; Industry and Government Work Out Safety Measures That Reduce Danger From Smoke or Gas in Cockpit. *Aviation Week*, Vol. 51, No. 7, August 15, 1949, pp. 52, 55, illus.

"Safety First" Is Motto of Air Transport Industry. Otto E. Kirchner. *SAE Journal*, Vol. 57, No. 8, August, 1949, pp. 42, 43. (Extended summary of a paper: Some Aspects of Air Transport Operation.)

Flight Testing (13)

Principles of Flight Testing. VII—Range Flying Techniques. *Aircraft*, Vol. 27, No. 10, July, 1949, pp. 19, 20, 38, 44, figs.

Remote Control for Prototype Testing of Piloted Aircraft. *U.S. Air Services*, Vol. 34, No. 8, p. 16.

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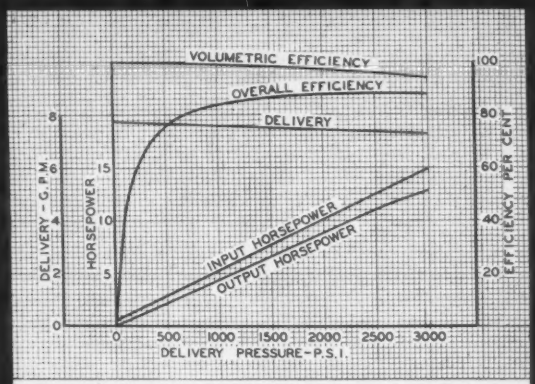

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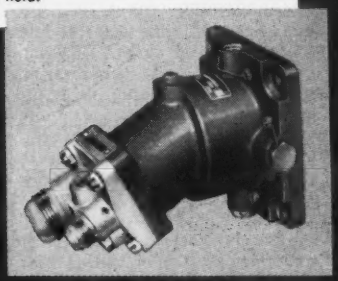

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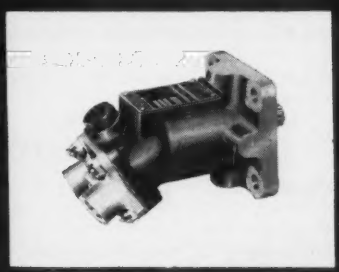

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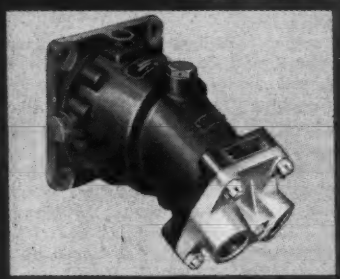

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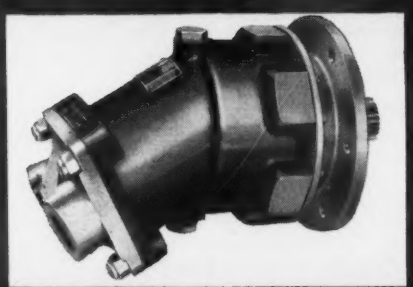

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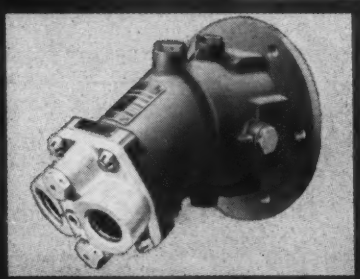

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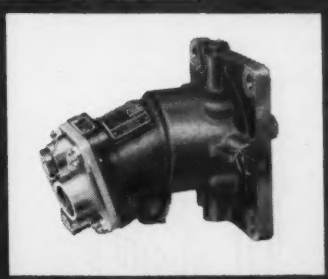

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Fuels & Lubricants (12)

High Compression Without High Octane; What Are Its Possibilities? I, II, III, IV. *Automotive Industries*, Vol. 101, Nos. 1, 2, 3, 4, July 1, 15, August 1, 15, 1949, pp. 28–31, 68, 70, 73; 36–39, 62, 64; 34–39, 58; 36–41, 67, 68, illus., diagrs., figs.

Conservation of fuel resources is advocated through better utilization of present petroleum supplies, increased production of superior synthetic products, and improved engine design. Although jet engines apparently have taken first place for military aircraft where speed is paramount and fuel consumption is secondary, a large field remains for piston-type engines and compound units. Higher compression ratios, leaner mixtures, and engine-design changes to provide greater internal cooling and freedom from detonation will make possible the use of larger amounts of the lower fractions of the crude. Piston engines capable of using low-grade fuel, possibly the same as the grades used for jet engines, would greatly simplify the problems of fuel supply for vehicles and aircraft. Detonation control, better fuel distribution in the engine, and elimination of internal hot spots can be attained by improved design. The theories and experiments of Ricardo, Janeway, and others regarding turbulence, compression pressure, flame temperature, flame propagation, quenching, and detonation laid the foundations for advancements in combustion-chamber design that can be further extended to get still better results. Examples are such engines as the Argyle single-sleeve, the Skinner split-sleeve, the Abell single-valve, and the Aspin rotating-combustion-chamber types, as well as other designs of mechanically operated overhead single-valve mechanisms permitting the elimination of the hot exhaust valve. It is possible to use compression ratios of 12 to 1 with 80-octane fuel, or 6 to 1 ratios with 55- or 60-octane fuel. An engine design using a positively operated overhead single-valve mechanism is suggested and described.

The Specific Heat of Napalm-Gasoline Gels. G. O. Langstroth and K. H. Hart. *Canadian Journal of Research, Section A, Physical Sciences*, Vol. 27, No. 4, July, 1949, pp. 151–155. 2 references.

Gliders (35)

Flugerfabrungen; Die Landung (Flying Practice; the Landing). Karl Kümpel. *Thermik*, Vol. 2, No. 7–8, July–August, 1949, pp. 138–140, diagrs.

Erfahrungen im Segelflugzeugbau (Sailplane Construction Knowhow). Edmund Schneider. *Thermik*, Vol. 2, No. 7–8, July–August, 1949, pp. 135, 136.

Schwanzloser Kleinsegler (Tailless Midget Sailplanes). Reimar Horten. *Thermik*, Vol. 2, No. 7–8, July–August, 1949, pp. 128, 129, 134.

Laminar-Profil im Segelflug (Laminar Profile for Planes). Wolfgang Hütter. *Thermik*, Vol. 2, No. 7–8, July–August, 1949, pp. 130, 131, diagrs.

Die Grösse des Wirtschaftlichen Leistungssegelflugzeuges (Dimension of an Economic Performance Sailplane). Wolfgang Hütter. *Thermik*, Vol. 2, No. 7–8, July–August, 1949, pp. 132–134, diagrs.

Schnellbau und Baukostensenkung (How to Speed up Construction and Keep Costs Down). *Thermik*, Vol. 2, No. 7–8, July–August, 1949, p. 137. (In German.)

Weltraumfahrt und Segelflug (Interplanetary Flight and Soaring). Von H. H. Kölle. *Thermik*, Vol. 2, No. 7–8, July–August, 1949, p. 112.

Segelflug in Deutschland (Soaring in Germany). Von Hans Haack. *Thermik*, Vol. 2, No. 7–8, July–August 1949, pp. 110–112.

Wellensegelflug (Wave Soaring). Conclusion. W. Georgii. *Thermik*, Vol. 2, No. 7–8, July–August, 1949, pp. 126–128, illus., diagrs.

Segelflug in Argentinien (Argentine Soaring). *Thermik*, Vol. 2, No. 7–8, July–August, 1949, pp. 121, 122, illus.

Die Technische Entwicklung im Französischen Segelflug (Technical Trends of French Soaring). Henri Mangeot. *Thermik*, Vol. 2, No. 7–8, July–August, 1949, pp. 119, 120, fig.

Segel- und Modellflug in Italien (Soaring and Modeling in Italy). L. Gf. Ysenburg. *Thermik*, Vol. 2, No. 7–8, July–August, 1949, pp. 117–119, illus.

Segelflug in Spanien. (Soaring in Spain). Joaquin Fernandez Quintanilla. *Thermik*, Vol. 2, No. 7–8, July–August, 1949, pp. 114–115, illus.

Gliding Instruction; The Movement at the Cross-Roads, Which Way Out? Ann Douglas. *Flight*, Vol. 56, No. 2115, July 7, 1949, pp. 13, 14, illus.

Koma; A New Hungarian Two-Seater Training Glider. Ernest Nagy. *Sailplane and Glider*, Vol. 17, No. 7, July, 1949, pp. 148, 149, illus.

The American 16th National Soaring Contest. *Sailplane and Glider*, Vol. 17, No. 8, August, 1949, pp. 170–177, illus.

Guided Missiles (1)

The Guidance of Rocket Missiles. Hermann Oberth. *Interavia*, Vol. 4, No. 8, August, 1949, pp. 477–480, illus., diagrs., figs.

A comparison of the beam-guidance system with the command-control system. The former uses a rotating dipole antenna and parabolic reflector by which signals are amplified, rectified and relayed to control surfaces which influence the movement of the missile. The command-control system operates by means of modulated continuous waves transmitted by radio from the ground-control station. Each rocket responds only to a given carrier frequency so that several missiles can be guided simultaneously and independently. Differences in modulation frequency counteract enemy efforts at jamming the controls. An improved control device designed by the writer, disclosed for the first time, involves dihedral wings, a switch-over drum, and counter-rotating gyro rotors controlled by magnetic rods. Five basic disadvantages of the beam-guidance system are: (1) it is difficult to hold the missile in the center of the beam; (2) receiving equipment in the missile must be carefully and precisely manufactured, involving increased cost; (3) it can be jammed easily by scattering metal foil or the like in the guiding beam; (4) the beam can be tracked readily by the enemy, but a command-control transmitter can relay its signals to several "slave" transmitters so that destruction of one unit would not destroy the entire installation; and (5) the command-control system could be used against ground targets as well as aerial targets.

A German Television Homing System. J. E. Libbert and Werner Rambauske. *U.S., Air Force, Technical Report No. F-TR-2161-ND*, September, 1947. 27 pp., figs.

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FLIGHT RESEARCH INSTRUMENTATION

GYROSCOPICS—SERVOMECHANISMS

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A television homing device invented by Dr. Werner Rambauske. The first part of the report, written by Dr. Rambauske, comprises a general description of the device, its application, and its limitations. The appendix, by Captain J. E. Libbert, gives a brief technical description of the device, correlated from various papers. The device is unique in many respects; e.g., in the use of a miniature iconoscope and of rectangular coordinate control, rather than quadrant control. Prototype equipment has been built and demonstrated.

Comparison of Different Types of Pursuit Curves. Geissler and Ludwig. (*Peenemünde, Heeresanstalt, ZWB/W VA/PA/86/113*, November, 1942.) *U.S., Air Force, Translation No. F-TS-1116-RE*, June, 1947. 6 pp., figs.

Ground-to-air guided missile trajectories are computed by means of pursuit curves. Of the three known types of curves characteristic of ground-to-air missiles, which are the beam rider curve, the ideal pursuit curve, and the aerodynamic pursuit curve, the beam rider is best. In the event corrections are necessary, they can be made by superposition of the target-seeking phase at the end of the trajectory.

Stability of the A-5 Ground-To-Ground Guided Missile About its Trajectory. Ludwig. (*Peenemünde, Heeresversuchsstelle, ZWB/PA/86/47*, September, 1940.) *U.S., Air Force, Translation No. F-TS-1111-RE*, August, 1947. 25 pp., figs.

Suggestions for achievement of stability and control characteristics suitable for application to guided missile A-5. Required parameters are laid down and recommendations are made for development of control equipment.

Vertical Climb of a Controlled Flying Body. (*Göttingen, Technische Hochschule, ZWB/THG/41/9.*) *U.S., Air Force, Translation No. F-TS-2637-RE*, August, 1947. 6 pp., figs.

The climb is greatly accelerated because of the rapid decrease of air density as altitude increases, and because the law of drag changes with increasing velocity. The numerical and graphical method that is outlined permits a close approximation of the solution for any given dependence of the air forces and air density on the velocity, without neglecting the lift of the tail unit in relation to the wing lift.

The German Guided Missile X-4. F. E. Patton. *U.S., Air Force, Summary Report No. F-SU-2131-ND*, June, 1947. 116 pp., illus., diagrs., figs. 29 references.

Summarizes available data on German Guided Missile X-4 with details of control, radio, airframe, propulsion, production, laboratory calculations, and experiments. It was considered Germany's most effective air-to-air controlled missile, especially against bomber formations. History of Dr. Ing. Max Kramer, chief designer, is recorded, as well as other personnel connected with the X-4 project. Report covers specifications, performance data, warhead and fuse and launching devices. The report is profusely illustrated and has an adequate bibliography.

Lateral Control With Gyro-Pendulum for A-5 Missile. Eichler. (*Peenemünde, Heeresversuchsstelle, ZWB/PA/86/45*, September, 1940.) *U.S., Air Force, Translation No. F-TS-2111-RE*, January, 1948. 8 pp., diagrs.

The guide beam is assumed to have been replaced by a pendulum and an integrator which measures lateral deviation, angle of yaw, time integral, and the first and second deviations. The stability ranges, within which the mixing ratios of pendulum signals must be chosen, are investigated. They are based on five different sets of vane motor constants.

Calculations of Skin Temperatures of the A-4 Guided Missile. Hild. (*Peenemünde, Heeresversuchsstelle, ZWB/PA/68/9*, November, 1940.) *U.S., Air Force, Translation No. F-TS-3109-RE*, February, 1948. 8 pp., figs.

Calculations to determine outer skin temperature of winged A-4 during flight are based on flight path previously determined. Highest temperature during climb, 260°C., was attained in 80th sec. Skin cools to 202°C., then heats to maximum of 283°C. in 240th sec. As result of decreasing velocity, tempeature drops steadily after 240th sec.

Guide-Beam Control Constants for A-4 Rocket Variable with Time. F. Schubert, Spehr, and Hoelker. (*Peenemünde, Heeresanstalt, ZWB/PA/86/123*, April, 1943.) *U.S., Air Force, Translation No. F-TS-2784-RE*, February, 1948. 23 pp., figs.

Continuation of numerical investigations of stabilization factors concerning guided missiles. Results show that proportions of guide-beam control constants to each other are varied and that damping obtained by use of guide-beam constants is far less favorable than that obtained by constants that vary with time.

Effect of Load Factors of C 1, C 2, C 3, Ground-to-Air Guided Missiles on the Possibilities of Hitting. Geissler and Ludwig. (*Pennemünde, Heeresanstalt, ZWB/PA/86-116*, January, 1943.) *U.S., Air Force, Translation No. F-TS-2143-RE*, February, 1948. 14 pp., diagrs., figs.

Determination of hit possibilities of a guided missile overtaking an aircraft. Calculations were based on aircraft flying straight course and engaging in evasive action. Missile upon which calculations were based developed thrust of 8,000 kg. for a period of 45 sec. Results of calculations included.

Investigation of Stability Range for Guided Missiles With Control Fin Position Coordination. Reta Gebert. (*Peenemünde, Heeresversuchsstelle, ZWB/PA/86/43*, September, 1940.) *U.S., Air Force, Translation No. F-TS-112-RE*, August, 1947. 57 pp., figs.

Theoretical calculations made to determine effects on stability range when coefficients in control and moment equations are revised. Coefficient changes made were for acceleration, mass, and exhaust velocity, and stability is calculated for two different angles of attack. Graphs show the stability curves for the A-IV guided missile.

Application of Locus-Curve Theory to Control Problems. Ludwig. (*Peenemünde, Heeresversuchsstelle, ZWB/PA/86/85*, June 20, 1941.) *U.S., Air Force, Translation No. F-TS-2131-RE*, January, 1948. 41 pp., figs.

The locus curve method used in electromagnetic wave theory is readily adaptable to the solution of those types of missile oscillations which have their origin in external disturbances. The locus curve represents the complex oscillation amplitude when the amplitude of the disturbance is equal to unity. For any disturbance amplitude, A, the complex oscillation amplitude is obtained through graphic multiplication of the locus curve value by A.

Investigations on Stability of a Guide-Beam Controlled, Ground-to-Air Guided Missile. Hans Hoch. (*Göttingen, Universität, Institut für Angewandte Mechanik, ZWB/FB/1892-8*, November 13, 1944.) *U.S., Air Force, Translation No. F-TS-2169-RE*, January, 1948. 19 pp., illus.

Possibility is investigated of giving exact curvature at every point of trajectory when guide beam is turned at variable rate and velocity of missile is not constant. Span of guide necessary to compensate for force of gravity and centrifugal force is shown. Target error, caused by detonation of projectile at incorrect time, is considered. Angle of attack and control-surface angle required to compensate for centrifugal force are determined for case in which target in vertical plane flies over guide-beam transmitter.

Pursuit Curves—Particularly Acoustic Curves. Gerbes. (*Oberpfaffenhofen, Flugfunk-Forschungsinstitut, ZWB/FB/1999*, September, 1944.) *U.S., Air Force, Translation No. F-TS-2183-RE*, August, 1947. 37 pp., diagrs.

Investigation of pursuit curves developed when heading in direction of noise produced by a target assumed to fly at constant speed in a straight line. Test was made to compare acoustic curves with common dog curves. Differential equations and graphs for calculations of pursuit curves are given. Findings show acoustic curves require less acceleration than dog curves when approaching target.

What Upper Air Means to Missiles; Rand Report Details Some of Problems Designers Have to Face in Planning Vehicles to Operate at 300-Mile Altitudes or Beyond. Robert McLarren. *Aviation Week*, Vol. 51, No. 8, August 22, 1949, pp. 21, 22, 24–26, figs. 18 references.

How Good Are Guided Missiles? George P. Sutton. *Flying*, Vol. 45, No. 3, September, 1949, pp. 18–20, 70, 71, illus.

Methods for Recovery of Guided Missiles. Karl Hipp. (*Stuttgart, Forschungsanstalt Graf Zeppelin, ZWB/UM/709*, December, 1942.) *U.S., Air Force, Translation No. F-TS-3087-RE*, March, 1948. 35 pp., figs.

Study of the Lateral Guide-Beam Control of the V-2 Missile. Shubert and Spehr. (*Peenemünde, Arbeitsgemeinschaft Vorhaben, ZWB/PA/86/74*, February 3, 1941.) *U.S., Air Force, Technical Report No. F-TS-2122-RE*, February, 1948. 16 pp., figs.

Longitudinal Motion of Missiles With Automatic Target-Seeking Control. W. von Treuenfels. (*Berlin, Allgemeine Elektricitäts-Gesellschaft, ZWB/FB/1971*, September, 1944.) *U.S., Air Force, Translation No. F-TS-2171-RE*, February, 1948. 22 pp., figs.

CREATIVE POWER

The creative power of D. F. "Truly" Warner, designing engineer with General Electric's Aircraft Gas Turbine Divisions, sparked the design or development of five great G-E jet engines. With an impressive design background in steam turbines and turbosuperchargers, Warner pioneered aircraft gas turbine development in this country. His first work was based on the original Whittle engine.

He designed the I-A and I-16 engines which powered Bell's P-59—the first jet-propelled plane in the United States. He supervised the design of the I-40 engine—power source for Lockheed's F-80 "Shooting Star." In 1945 he took over further development of the J35 engine originally designed in Schenectady. Shortly after, he supervised design and development of the J47, one of the most powerful jet engines in production. The J47 furnishes power for North American's F-86 and B-45A, Boeing's B-47, Republic's XF-91, and supplements G-E turbosupercharged piston engine power in Convair's B-36.

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GENERAL ELECTRIC

Wind-Tunnel Tests in Connection with Stabilization of Projectiles With Control Surfaces Held to Size of One Caliber at Supersonic Speed. O. Walchner. (*Göttingen, Aerodynamische Versuchsanstalt, ZWB/A VAG/43/H/03,* January, 1943.) U.S., *Air Force, Translation No. F-TS-3436-RE,* February, 1948. 6 pp., figs.

Heating of Bulkhead Ribs Through Outer Surface of Guided Missiles. Hase. (*Hannover, Technische Hochschule, ZWB/TH Hann/47/14,* May, 1942.) *U.S., Air Force, Translation No. F-TS-2428-RE,* February, 1948. 8 pp., figs.

Supersonic Guided Missile Progress. II—Propulsion Systems. Ralph E. Gibson. *Aero Digest,* Vol. 59, No. 2, August, 1949, pp. 48–50, diagr., figs.

Radar Tracking of Guided Missiles. II—Proposed High Precision Direction-Finding System. Hans H. Zschirnt. *U.S., Air Force, Technical Report No. F-TR-2166B-ND,* May, 1948. 12 pp., figs.

Summary Report on A-4 Control and Stability. Henry Friedman. *U.S., Air Force, Summary Report No. F-SU-2152-ND,* June, 1947. 247 pp., figs. 44 references.

Report of Evaluation of a German Battery for Use in Guided Missiles. (*General Electric Company, Research Laboratory.*) *U.S., Air Force, Technical Report No. F-TR-2117B-ND,* February, 1948. 24 pp., figs.

Calculations of the Gyropilot Made by Kreiselgeraete. Frederick. (*Peenemünde, ZWB/PA/86/14,* November, 1939.) *U.S., Air Force, Translation No. F-TS-2102-RE,* August, 1947. 8 pp.

Stability of Oscillations Perpendicular to the Plane of the Trajectory for a Guided Missile Equipped With Möller Control Apparatus. Ludwig. (*Peenemünde, Heeresversuchsstelle, ZWB/PA/86-49,* September, 1940.) *U.S., Air Force, Translation No. F-TS-2112-RE,* August, 1947. 25 pp., diagrs., figs.

Curvature of Trajectory of C-1, C-2 and C-3 Ground-to-Air Guided Missiles and Calculations of the Launching and Impact Regions of the Trajectory. Geissler and Ludwig. (*Peenemünde, Heeresversuchsstelle, ZWB/PA/86-117,* February, 1943.) *U.S., Air Force, Translation No. F-TS-2144-RE,* July, 1947. 15 pp., diagrs., figs.

Guide-Beam Modulation for A-4 Guided Missile with Siemens Automatic Pilot. R. Schubert. (*Peenemünde, Heeresversuchsstelle, ZWB/PA/86/87,* July, 1941.) *U.S., Air Force, Translation No. F-TS-2013-RE,* February, 1948. 10 pp., figs.

Investigation of the Möller Gyro With Supplementary Spring. Ernst Geissler. (*Peenemünde, Heeresversuchsstelle, ZWB/PA/86/28,* May 1940.) *U.S., Air Force, Translation No. F-TS-2107-RE,* July, 1947. 9 pp., diagrs.

Stability Investigations of Lateral Guide-Beam Control for the V-2 Guided Missile. Hoelker. (*Peenemünde, Heeresversuchsstelle, ZWB/PA/86/55,* November, 1940.) *U.S., Air Force, Translation No. F-TS-2113-RE,* January, 1948. 6 pp., diagrs., figs.

Test Firing of R-L Guided Missile, "Rheintochter." Fricke. (*PM/Rtr/PS/P/8,* July, 1944.) *U.S., Air Force, Translation No. F-TS-3262-RE,* August, 1947. 2 pp.

Comparison of Stability Investigations on Projectiles With Various Fins. Lehnert-Herrmann. (*Peenemünde, Heeresversuchsstelle, ZWB/WVA/PA/66/87,* November, 1942.) *U.S., Air Force, Translation No. F-TS-1999-RE,* February, 1948. 9 pp., figs.

Correction of Roll Developing Shortly After Launching of Missile. Ludwig. (*Peenemünde, Heeresversuchsstelle, ZWB/PA/86/91,* September, 1941.) *U.S., Air Force, Translation No. F-TS-2136-RE,* January, 1948. 18 pp., diagrs.

Second Viking Rocket Will Soon Be Ready to Explore Conditions in Air Above Stratosphere. *The Martin Star,* Vol. 8, No. 8, August, 1949, pp. 10–12, illus.

Experimental Investigations of the SAM-Control Mechanism D 13 and Determination of the Coefficients A_ν and m_ν of Its Control Equation According to Report A/c 71. Fredrich and Ludwig. (*Peenemünde, Heeresversuchsstelle, ZWB/PA/86/72,* February, 1941.) *U.S., Air Force, Translation No. F-TS-2120-RE,* April, 1947. 15 pp., figs.

Instruments

AIRCRAFT (9)

Determination of Heat Transfer Coefficients During High Speed Flight. John L. Beal. *Cornell Aeronautical Laboratory, Inc., Report No. HF-601-M,* April 11, 1949. 24 pp., figs.

Preliminary investigation for the design of measuring devices. This pertains to the anticipated range of operating conditions indicated by an estimated range of air temperature, flight velocity, and the rate of their variance in high speed flight. An extremely rapid response is required. The most rapid response is obtained with the utilization of very thin metal films that are fabricated by a commercial electrolytic process. The devices can be built with high relative strength and accuracy.

Magnetic Compass Problems; A Fresh Approach. G. N. Harvey. *Institute of Navigation, Journal,* Vol. 2, No. 3, July, 1949, pp. 230–242, diagrs., figs.

Methods of degaussing and compensating compasses. An aircraft compass mounting is described which is kept parallel to the earth surface during a level turn by the centrifugal force developed by the turn.

Zero Reader; Air Experience of Sperry's New Flight Instrument, Simplified Presentation for Flying, Navigation and Landing Approach. *Flight,* Vol. 56, No. 2121, August 18, 1949, pp. 182–185, illus., figs.

Zero Reader. F. Glen Nesbitt. *Canadian Aviation,* Vol. 22, No. 8, August, 1949, pp. 24–26, 50, illus., figs.

Counter Replaces Two Pointers on Altimeter Dial. *Product Engineering,* Vol. 20, No. 8, August, 1949, p. 95, illus., diagrs. The "160" altimeter of the Kollsman Instrument Division of Square D Company.

The Sperry Gyroscope Company, Limited of London, England. Arthur Hillier. *Sperryscope,* Vol. 11, No. 10, Summer, 1949, pp. 14–17, illus. Review of the growth of the British unit of the Sperry organization and of the development and use of various Sperry instruments for marine and air navigation.

TEST & MEASURING

Tests of Instruments for the Determination, Indication, or Recording of the Specific Gravities of Gases. *U.S., Bureau of Standards, Miscellaneous Publication No. M177,* January 20, 1947. 143 pp., illus., diagrs., figs.

The New Du Mont Type 314-A Oscillograph-Record Camera; A Report on the Changes in This Versatile Instrument, Together With Notes on Extending its Utility. H. P. Mansberg. *The Oscillographer,* Vol. 11, No. 3, July–September, 1949, pp. 3–8, 19, 20, illus., diagrs., figs.

Instrumentation for Measuring Temperature and Pressure of Luminous Flames of Short Duration. O. E. Teichmann. *Heat Transfer and Fluid Mechanics Institute, University of California, Berkeley, Calif.,* June 22–24, 1949, pp. 201–210, illus., diagrs., figs American Society of Mechanical Engineers, New York. $5.00.

An Improved Ultramicrometer According to Dowling's Method. Gotthard Gustafsson. (*Stockholm, Royal Institute of Technology, Division of Physics,* January, 1935.) *Royal Swedish Air Board, Translation No. 6,* 1948. 6 pp., diagrs., figs. 3 references. (In English.)

Lighter-Than-Air (40)

The Balloonist Who Was Goethe. Alex Meyer. *Interavia,* Vol. 4, No. 8, August, 1949, p. 500, illus.

LTA (Lighter-Than-Air) Reserves Are Part of (Anti-Submarine Warfare) Team. *Naval Aviation News,* No. 28, August, 1949, pp. 27–29, illus.

Machine Elements (14)

Equality of Strength and Stress in Design of Machine Parts. Charles Lipson, G. C. Noll, and L. S. Clock. *Product Engineering,* Vol. 20, No. 8, August, 1949, pp. 86, 87, diagrs.

Evaluation of an index or design factor for predicting the balance between stress and strength that is satisfactory both from the point of view of possible failure and of economical design.

Machine Dials and Scales. W. R. Garner and J. W. Gebhard. *Machine Design,* Vol. 21, No. 8, August, 1949, pp. 98–105, figs. 10 references.

AUTOMATIC CONTROL

Methods for Determining Frequency Response of Engines and Control Systems From Transient Data. Melvin E. LaVerne and Aaron S. Bokesenbom. *U.S., N.A.C.A., Technical Note No. 1935,* August, 1949. 29 pp., figs. 4 references.

Methods are presented that use general correlative time-response input and output data for a linear system to determine the frequency-response function of that system. These methods give an exact description of any linear system for which such transient data are available. Examples are shown of application of a method to both an underdamped and a critically damped exact second-order system, and to an exact first-order system with and without dead time. Experimental data for a turbine-propeller engine showing the response of engine speed to change in propeller-blade angle are presented and analyzed.

Fundamentals of Automatic Control. II. W. Oppelt. *The Engineers' Digest,* Vol. 10, No. 7, July, 1949, pp. 237–241, figs.

BEARINGS

Preliminary Investigation of Needle Bearings of 1 1/8-Inch Pitch Diameter at Speeds to 17,000 r.p.m. E. Fred Macks. *U.S., N.A.C.A., Technical Note No. 1920,* August, 1949. 76 pp., illus., diagrs., figs. 19 references.

The Mechanical Seal, Its Construction, Application, and Utility. C. E. Schmitz. *American Society of Mechanical Engineers, Transactions,* Vol. 71, No. 6, August, 1949, pp. 635–641, diagrs.

FRICTION

Fundamental Work on Friction, Lubrication, and Wear in Germany During the War Years. E. D. Tingle. (*Gt. Brit., British Intelligence Objectives Survey, Final Report No. 1610.*) *Institute of Petroleum, Journal,* Vol. 34, No. 298, October, 1948, pp. 743–773. (Reprint.)

Collisions Through Liquid Layers. D. Tabor. *Engineering,* Vol. 167, pp. 145–148, February 18, 1949, illus., figs. 12 references.

Experimental study of the nature of the contact between colliding steel spheres coated with lubricants of various viscosities. Contact was described by conductance curves of the lubricants. The impact of spheres filmed with caprylic acid, viscosity of 6 centipoise, produced a conductance curve similar to that for spheres with uncoated surfaces. With a film of medicinal oil, viscosity of 120 centipoise, conductance was zero but deformation of the surfaces occurred. When the instance of impact is sufficiently short, hydrodynamic forces developed in the fluid are sufficient to produce a plastic flow in the metal. Heating due to the plastic deformation of colliding spheres is reduced or eliminated when the surfaces are separated by a lubricant.

Research into Boundary Lubrication. (*Maschinebau und Wärmewirtschaft,* Vol. 3, Nos. 4, 5, April, May, 1948, pp. 57–61, 75–78.) *The Engineers' Digest,* Vol. 10, No. 7, July, 1949, p. 232. 2 references.

KINEMATICS OF MACHINERY

Centrifugal Pendulum Dynamic Dampers. Chu, Chen. *Chinese Institute of Engineers, American Section, Journal,* Vol. 6, 7, Nos. 1, 2, May, 1949, pp. 146–164, figs. 7 references.

Different types of centrifugal pendulum dynamic dampers are briefly treated in this article. Stress is laid on the method of approach and derivation. Oscillations of large amplitude are included.

On Connecting Rod-Crank Mechanism. Necdet Eraslan. *L' Universite-d'Istanbul, La Faculté des Sciences, Revue, Serie A: Mathematiques, Physique, Chimie,* Vol. No. 14, Fascicule 2, April, 1949, pp. 86–89, figs. (In English.)

Kinematics of Intermittent Mechanisms. II—The Internal Geneva Wheel. S. Rappaport. *Product Engineering,* Vol. 20, No. 8, August, 1949, pp. 109–112, illus., figs.

Balancing Crank Mechanisms. C. R. Freberg, R. C. Johnson, and S. D. Moxley, Jr. *Machine Design,* Vol. 21, No. 8, August, 1949, pp. 111–116, diagrs., figs.

TRANSMISSIONS, CLUTCHES & DRIVES

Fluid Magnetic Clutches. *Duncan & Bayley, Inc., Brochure,* 1949. 12 pp., illus., figs. Descriptions, specifications, installation dimensions, performance charts, and lists of military and industrial applications of various models of torque controllers.

Maintenance (25)

Mass-Production Maintenance; Spectacular Equipment Used by United Air Lines at New San Francisco Base. Robert Russell. *Flight,* Vol. 56, No. 2117, July 21, 1949, pp. 77–79, illus.

Aircraft Engine Major Overhaul. Harold J. Farrow. *Canadian Aviation,* Vol. 22, No. 8, August, 1949, pp. 42, 44.

Pit and Underwing Servicing Proved Successful by NWA. William D. Perreault. *American Aviation,* Vol. 13, No. 6, August 15, 1949, pp. 36, 37, illus.

Boeing Service Guide, No. 23, August, 1949. Contents: Cabin Air Temperature Control. Emergency Brake Metering Valve Adjustment. Rudder Control Close-Tolerance Bolts. Geneva-Loc Actuator. Thermal Anti-Icing Balancing Circuit. Air Conditioning Filter Element Part Number. Alternator Installation Precaution. Nose Gear Towing Mark. Differential Pressure Switch Settings. Ring Cowl Forward Latch Housing Drain Provisions. Nose Gear Actuator Installation Precaution. Rudder Hinge Bolt Installation. Yaw Meter. Revision in Maintenance of Acrylic Plastic Windows. Propeller Feathering. Lavatory Service Connections. Fuel Boost Pump Pressures. Engine Accessory Drive Adapter Installation.

Douglas Service, Vol. 8, No. 4, July–August, 1949. 20 pp., diagrs., figs. Contents: Super DC-3 Hydraulic System—Improvement Changes in New System, Super DC-3. Stepmotor Tester—Visual Indication of Control Current Delivered to Stepmotor, DC-6. Concentrated Weight Distribution—Loading Fuselage Floors Correctly, C-54, DC-4. Special Tools—For Torquing Inner-to-Outer Wing Attach Studs, DC-6. Radio Noise—Recommendations to Eliminate Background Interference, DC-6. Cabin Window Identification, DC-6. Solenoid Control Head, DC-4, DC-6. Advance Engineering Changes, DC-6. Fuel Dumping Rates, DC-4, DC-6. Hydraulic System Schematic, Super DC-3. Wing Heaviness-String Method of Correction, DC-3, C-47. Integral Fuel Tank Sealing. Drain Holes and Drain Lines, DC-6. Pratt & Whitney R-2000 Series Engines, C-54, DC-4.

Materials (8)

METALS & ALLOYS

Mechanical Tests and the Working Properties of Metals. G. Fitzgerald-Lee. *Aircraft Engineering,* Vol. 21, No. 245, July, 1949, pp. 220, 221, 226, fig.

Descriptions of apparatus and methods for mechanical testing of metals, especially aluminum and its alloys. Working properties of metals and means for measuring such properties also are reviewed.

Comparison of High-Temperature Alloys Tested as Blades in a Type B Turbosupercharger. W. C. Stewart and H. C. Ellinghausen. *American Society of Mechanical Engineers, Transactions,* Vol. 71, No. 6, August, 1949, pp. 613–620, illus., diagrs., figs. 16 references.

The authors describe briefly a series of jet tests, utilizing gas produced from the combustion of Diesel fuel oil, as a means for comparing the resistance of a number of high-temperature alloys to hot-gas impingement. The deficiencies of this method for simulating conditions in a gas turbine are discussed. The paper is concerned principally with comparative tests of a number of high-temperature alloys when tested in the form of blades in a Type B turbosupercharger. The test rotor contains 142 blades representing 12 different alloys. Both wrought and precision-cast blades are included. Tests were made at eight temperatures, ranging from approximately 1,200° to 1,500°F., test runs at each temperature being of 50 to 150 hours' duration, except in the case of the 1,500°F. test run, which was continued for 1,000 hours. After several of the test runs, measurements were made to determine the amount of permanent extension in the blades and disc. The extension of the blades and disc accompanying progressively higher testing temperatures is shown graphically. A procedure for correlating the metal temperature of the blades with that of the combustion gas in the nozzle chamber of the supercharger is described.

Materials in the Aircraft Industry. Clyde Williams. *Materials & Methods,* Vol. 30, No. 2, August, 1949, pp. 51–54, illus., figs.

Heat-Resistant (Haynes Stellite Co.) Alloys for Aviation. F. S. Boericke. *Aero Digest*, Vol. 59, No. 2, August, 1949, pp. 43–45, illus., fig.

Changes in Internal Damping of Gas-Turbine Materials Due to Continuous Vibration. G. B. Wilkes, Jr. *American Society of Mechanical Engineers, Transactions*, Vol. 71, No. 6, August, 1949, pp. 631–634, diagrs., figs. 3 references.

The Bureau of Aeronautics' Magnesium Program. J. E. Sullivan. *Magnesium*, August, 1949, pp. 8–11, illus.

New alloys based on magnesium, lithium, cadmium, zinc, silver, aluminum, cerium, and other metals in various compositions have demonstrated superior strength and heat properties. Extensive stress, corrosion and ballistic tests on new and existing alloys have developed improved techniques and applications.

Wrought Aluminium and Aluminium Alloys; Sheet and Strip. *British Standards Institution, British Standard No. 1470*, 1948. 31 pp., tables. 3*s*. 6*d*.

Behaviour of Cast Steel at Elevated Temperatures. I, II, III, IV. A. E. Johnson. *The Engineer*, Vol. 188, Nos. 4879, 4880, 4881, 4882, July 29, August 5, 12, 19, 1949, pp. 126–128; 138–141; 165–168; 189–191, diagrs., figs. 13 references.

Fundamental Effects of Aging on Creep Properties of Solution-Treated Low-Carbon N-155 Alloy. D. N. Frey, J. W. Freeman, and A. E. White. *U.S., N.A.C.A., Technical Note No. 1940*, August, 1949. 73 pp., illus., diagrs., figs. 14 references.

NONMETALLIC MATERIALS

The Applicability of Ceramics and Ceramals as Turbine-Blade Materials for the Newer Aircraft Power Plants. A. R. Bobrowsky. *American Society of Mechanical Engineers, Transactions*, Vol. 71, No. 6, August, 1949, pp. 621–629, fig. 10 references.

Tensile, flexure, thermal-shock, and oxidation data were compared with those of alloys at temperatures up to 2,400° F. Carbide-base materials possess good thermal-shock resistance and operate cooler than most high-temperature alloys or oxide-base materials, although they may present oxidation problems and difficulties with wheel cooling. At 1,800° F. the best ceramal is competitive in thermal strength with the best commercial heat-resistant alloy and with the best National Bureau of Standards ceramic, but it is inferior to the best hot-pressed ceramic. At 2,200°F. the best ceramal is superior to the best commercial heat-resistant alloy and is competitive with the best hot-pressed ceramic. Both ceramics and ceramals have been used for gas-turbine blades at temperatures above those in operation with alloy blades, although at lower speeds. The service life of ceramic and ceramal materials is still short, primarily because of mechanical design problems that cannot be anticipated prior to research evaluation.

Elevated-Temperature Properties of Several Titanium Carbide Base Ceramals. George C. Deutsch, Andrew J. Repko, and William G. Lidman. *U.S., N.A.C.A., Technical Note No. 1915*, July, 1949. 47 pp., illus., figs. 8 references.

Investigation of Bonding Between Metals and Ceramics. I—Nickel, Cobalt, Iron, or Chromium With Boron Carbide. H. J. Hamjian and W. G. Lidman. *U.S., N.A.C.A., Technical Note No. 1948*, September, 1949. 23 pp., illus., diagrs. 10 references.

Synthetic Resin Adhesives; Heinkel & Co. G. Hermon Slade. *Gt. Brit., British Intelligence Objectives Sub-Committee, Final Report No. 1795, Item No. 22*, December, 1946. 4 pp. British Information Services, New York. 1*s*.

Solvents by Shell; Industrial Chemicals From a Vast New British Plant. *Flight*, Vol. 56, No. 2115, July 7, 1949, p. 28, illus.

Treatment of Nylon Webbing to Increase Resistance to Abrasion. C. A. Willis. *U.S., Central Air Documents Office (Navy-Air Force), Technical Data Digest*, Vol. 14, No. 15, August 1, 1949, 1949, pp. 15–25, figs., tables.

Internal Research; Studies of New Plastics Materials. Harold W. Haugan. *Cornell Aeronautical Laboratory, Inc., Final Report No. PA-561-M-1*, February 15, 1949. 10 pp. Research for improving the adherence of silicone resins to glass cloth laminates.

PROTECTIVE COATINGS

Fire-Retardant Coatings for Aircraft. *U.S., National Bureau of Standards, Technical Report No. 1363*, August, 1949. 11 pp., illus., diagrs. 1 reference.

Fire-Retardant Coatings Evaluated; Studies Made Under Joint NBS-CAA Program Aim to Boost Resistance of Fabric-Covered Aircraft Surfaces. *Aviation Week*, Vol. 51, No. 7, August 15, 1949, pp. 37, 38, 41, illus., diagr.

SANDWICH MATERIALS

Honeycomb-Sandwich Structures. I. H. C. Engel and T. P. Pajak. *Product Engineering*, Vol. 20, No. 8, August, 1949, pp. 81–85, illus., figs.

Fatigue of Sandwich Constructions for Aircraft; Fiberglas-Laminate Facing and Paper Honeycomb Core Sandwich Material Tested in Shear. Fred Werren. *U.S., Forest Products Laboratory, Madison, Wis., Report No. 1559-G*, February, 1949. 10 pp., illus., fig.

Flexural Rigidity of a Rectangular Strip of Sandwich Construction. H. W. March and C. B. Smith. *U.S., Forest Products Laboratory, Madison, Wis., Report No. 1505, Revised*, March, 1949. 21 pp., figs. 5 references.

Effect of Span-Depth Ratio and Thickness on the Mechanical Properties of a Typical Glass-Fabric-Base Plastic Laminate as Determined by Bending Tests. Fred Werren. *U.S., Forest Products Laboratory, Madison, Wis., Report No. 1807*. 16 pp., illus., diagrs.

Buckling of Flat Plywood Plates in Compression, Shear, or Combined Compression and Shear. L. A. Ringelstetter. *U.S., Forest Products Laboratory, Madison, Wis., Report No. 1316-J*. 7 pp., illus., diagrs.

Directional Properties of Glass-Fabric-Base Plastic Laminate Panels of Sizes That Do Not Buckle. Fred Werren and C. B. Norris. *U.S., Forest Products Laboratory, Madison, Wis., Report No. 1803*. 19 pp., illus., diagrs., figs.

Creep Tests of Sandwich Constructions Subjected to Shear at Normal Temperatures. A. W. Voss and C. B. Norris. *U.S., Forest Products Laboratory, Madison, Wis., Report No. 1806*. 9 pp., illus., diagrs., figs.

Elastic Stability of the Facings of Flat Sandwich Panels When Subjected to Combined Edgewise Stresses. K. H. Boller and C. B. Norris. *U.S., Forest Products Laboratory, Madison, Wis., Report No. 1802*, February, 1949. 15 pp., illus., figs.

Meteorology (30)

Jet Streams and Their Importance to Air Navigation. C. S. Durst and N. E. Davis. *Institute of Navigation, Journal*, Vol. 2, No. 3, July, 1949, pp. 210–221, figs. 6 references. Explanation and examples of the effect on air navigation of the fast-moving air streams sometimes found at 15,000 to 40,000 ft. altitudes.

An Analysis of the Relation Between Horizontal Temperature Variations and Maximum Effective Gust Velocities in Thunderstorms. H. Press and J. K. Thompson. *U.S., N.A.C.A., Technical Note No. 1917*, July, 1949. 12 pp., figs. 3 references.

International Civil Aviation Organization; Second Conference of I.C.A.O. North Atlantic Ocean Stations, London, 1949. C. E. N. Frankcom. *The Meteorological Magazine*, Vol. 78, No. 926, August, 1949, pp. 215, 216.

Boxing the Hurricane; Air Force Procedure for Tracking Tropical Storms. *Weatherwise*, Vol. 2, No. 4, August, 1949, pp. 84, 85, figs.

Equivalent Head Winds on Air Routes. A. F. Crossley. *Institute of Navigation, Journal*, Vol. 2, No. 3, July, 1949, pp. 195–209, figs. 4 references.

Réalisation d'un Appareil pour la Mesure Rapide de L'Épaisseur Réduite de L'Ozone Atmosphérique (Development of an Instrument for the Rapid Measurement of the Reduction in Density of Ozone in the Atmosphere). M. Etienne Vassy and Mme. Vassy. *France, Office National D'Études et de Recherches Aéronautiques, Rapport Technique No. 42*, 1948. 46 pp., diagrs., figs. 30 references. (In French.)

Military Aviation (24)

Peace in the Pacific. Norman Macmillan. *Aircraft*, Vol. 27, No. 10, July, 1949, pp. 12–15, illus.

Signing of a mutual defense pact and dispersal of U.K. wartime industries to such countries as Australia are vitally needed to maintain peace.

Navy Air Reserves Go to Sea. *The Aeroplane*, Vol. 77, No. 1991, August 5, 1949, pp. 169–171, illus.

The Air Defense of the United States. Floyd A. Lambert. *Antiaircraft Journal*, Vol. 92, No. 4, July–August, 1949, pp. 23–26, illus., diagr.

Navy Squadrons in the Berlin Airlift. *United States Naval Institute, Proceedings*, Vol. 75, No. 8, August, 1949, pp. 930–939, illus.

The Navy's AD-2 Skyraider
The AD-2 Skyraider is the standard carrier-based attack airplane of the U. S. Navy. Now in production at Douglas Aircraft's El Segundo Plant, it is recognized as possessing the ideal characteristics for carrier operations.
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Academy of Accuracy; Bombing Instructors' Course at the Empire Air Armament School. *Flight*, Vol. 56, No. 2118, July 28, 1949, pp. 99–101, illus.

Why B-36 Was Made USAF Top Bomber. Robert Hotz. *Aviation Week*, Vol. 51, No. 7, August 15, 1949, pp. 13–16, illus.

Rhein Main-Berlin Shuttle. Richard Malkin. *Air Transportation*, Vol. 15, No. 2, August, 1949, pp. 12, 13, 37, 38, 40, illus.

Navy Maps Alaska Oil. *Naval Aviation News*, No. 28, August, 1949, p. 12, illus.

Naval Fighter Development; The Evolution of the Naval Fighter to the Jet Types Now Entering the Field. Sydney Camm. *Aircraft*, Vol. 27, No. 10, July, 1949, pp. 21–23, 46, illus.

Entwicklung und Kriegsentscheidende Bedeutung der Luftkriegfuhrung im Zweiten Weltkrieg (The Development and Military Significance of Air-Warfare Doctrine in the Second World War). Georg W. Feuchter. *Flugwehr und -Technik*, Vol. 11, No. 8, August, 1949, pp. 171–176.

Voraussagen im Luftkrieg mit Hilfe der Wahrscheinlichkeitsrechnung (Prediction in Air Warfare by Means of Probability Calculation). O. P. Fuchs and H. Kottas. *Flugwehr und -Technik*, Vol. 11, No. 8, August, 1949, pp. 176–181, figs.

For Sweden's Air Defence; Arctic Practice for Men and Machines. *Flight*, Vol. 56, No. 2117, July 21, 1949, p. 80, illus.

Notre Armée de l'Air et la Défense Occidentale (Our Air Army and the Defence of the West). Laurent-Eynac. *L'Air*, Vol. 30, No. 629, July, 1949, p. 1.

Wanted: 1000 Navigators. Norman Hays. *Flying*, Vol. 45, No. 3, September, 1949, pp. 40, 41, illus.

Model Airplanes

The Navy's Flying Midgets. Jared Hamilton. *Flying*, Vol. 45, No. 3, September, 1949, pp. 38, 39, 74, illus.

Navigation (29)

The Modified Lambert Conformal Projection for Polar Areas. C. H. Ney. *Canadian Journal of Research, Section F, Technology*, Vol. 27, No. 6, June, 1949, pp. 269–283, figs.

Using Your ADF. Ben Robin. *Skyways*, Vol. 8, No. 9, September, 1949, pp. 30, 31, 51, 53, 57, 59, illus., diagr.

Proportional Dividers Compute Speed-Time-Distance. P. V. H. Weems. *Aero Digest*, Vol. 59, No. 2, August, 1949, pp. 65, 99, 100, figs.

Parachutes

Slotted Parachute Gives Better Control. *Aviation Week*, Vol. 51, No. 3, July 18, 1949, p. 24, illus.

Personal Flying (42)

Service After the Sale for Beechcraft Owners; Factory Field Work With Owners Through Authorized Service Stations Makes for Better Bonanza Utilization. Paul E. Allen. *Southern Flight*, Vol. 32, No. 2, August, 1949, pp. 10, 11, illus.

The Search for Higher Performance. Tom Ashley. *Southern Flight*, Vol. 32, No. 2, August, 1949, pp. 8, 9, 20, 24, 32, illus.

How to Baby Your Engine. I—What Propeller Should You Use? Peter Altman. *Flying*, Vol. 45, No. 3, September, 1949, pp. 16, 17, 68, 69, figs.

CAA Reorganization Strengthens Private Flying. Richard Saunders. *Flying*, Vol. 45, No. 3, September, 1949, pp. 21, 62, fig.

What Insurance Do You Need? William H. Rodda. *Flying*, Vol. 45, No. 3, September, 1949, pp. 32, 33, 56, 58–60, illus.

Ryan Cuts Navion Price $1000. *Aviation Week*, Vol. 51, No. 8, August 22, 1949, p. 35.

Photography (26)

Veiling Glare in Aerial Photography. K. M. Baird. *Canadian Journal of Research, Section A, Physical Sciences*, Vol. 27, No. 4, July, 1949, pp. 130–142, illus., figs. 5 references.

Veiling glare and its general aspects in aerial photography. Experimental results showing the effect of glare on the resolving power of a standard aerial film are presented in graphs. A method of measurement is described and typical amounts encountered in widely used aerial cameras are given. Veiling glare commonly causes a loss of photographic speed of as much as 100 per cent where resolving power is the primary consideration. Recommendations are made for minimizing flare in cameras.

Photogrammetry for the Non-Photogrammetrist. Edward S. Wood, Jr. *Photogrammetric Engineering*, Vol. 15, No. 2, June, 1949, pp. 249–275, illus., diagrs., figs.

Basic concepts of aerial mapping are explained for the engineer or city planner. They include fundamental terms, the approximate scale of vertical photographs, sources of error, radial line plotting, and the determination of elevation.

The Geometry of Photorectification. Howard Warren Clark. *Photogrammetric Engineering*, Vol. 15, No. 2, June, 1949, pp. 288–310, illus., diagrs., figs. 12 references.

Image displacements inherent in aerial photographs are explained and a general theorem is developed for geometrically correct rectification. The application of these principles to presently known and proposed rectifiers is exemplified.

Radar Mapping. R. R. Lowther. *Electronic Engineering*, Vol. 21, No. 258, August, 1949, pp. 279, 280, 299, illus.

Sea Skippers and Hot Pilots Alike Can't do Without Hydro Chart-Maps. *Naval Aviation News*, No. 28, August, 1949, pp. 2, 3, illus.

The Navigator's Problem in Aerial Survey. John Saffery. *Institute of Navigation, Journal*, Vol. 2, No. 3, July, 1949, pp. 222–226.

The Wet Process of Laying Mosaics. G. T. O'Neil. *Photogrammetric Engineering*, Vol. 15, No. 2, June, 1949, pp. 315–317.

Scale-Point Method of Tilt Determination. Ralph O. Anderson. *Photogrammetric Engineering*, Vol. 15, No. 2, June, 1949, pp. 311–314, diagr.

Aerial Survey of Southeastern Alaska 1948. Thomas F. Pollack. *Photogrammetric Engineering*, Vol. 15, No. 2, June, 1949, pp. 276–287, illus.

Air Photograph Interpretation in the Chimney Corner-Chéticamp Area, Cape Breton Island, N.S. H. L. Cameron. *Photogrammetric Engineering*, Vol. 15, No. 2, June, 1949, pp. 230–249, illus., diagrs. 13 references.

The Relief Displacement Factor in Forest Area Estimates by Dot Templets on Aerial Photographs. R. C. Wilson. *Photogrammetric Engineering*, Vol. 15, No. 2, June, 1949, pp. 225–236, diagrs., figs.

Panchromatic Versus Infrared Minus-Blue Aerial Photography for Forestry Purposes in California. Herbert A. Jensen and Robert N. Colwell. *Photogrammetric Engineering*, Vol. 15, No. 2, June, 1949, pp. 201–223, illus., diagrs., figs. 6 references.

Power Plants

Energy in the Engine Exhaust. P. H. Schweitzer and T. C. Tsu. *American Society of Mechanical Engineers, Transactions*, Vol. 71, No. 6, August, 1949, pp. 665–672, diagrs., figs. 5 references.

The maximum amount of energy which an ideal turbine can recover from the exhaust gas of an engine is the same as the additional energy obtainable from an ideal, complete-expansion piston engine. This energy, known as the convertible blowdown energy, is equal to the tail triangle of the *p-v* diagram. A chart is presented for the quick determination of the convertible blowdown energy for exhaust release pressures between 10 and 1,000 lbs. per sq.in. absolute, exhaust release temperatures between 0° and 4,000°F., and altitudes between sea level and 40,000 ft.

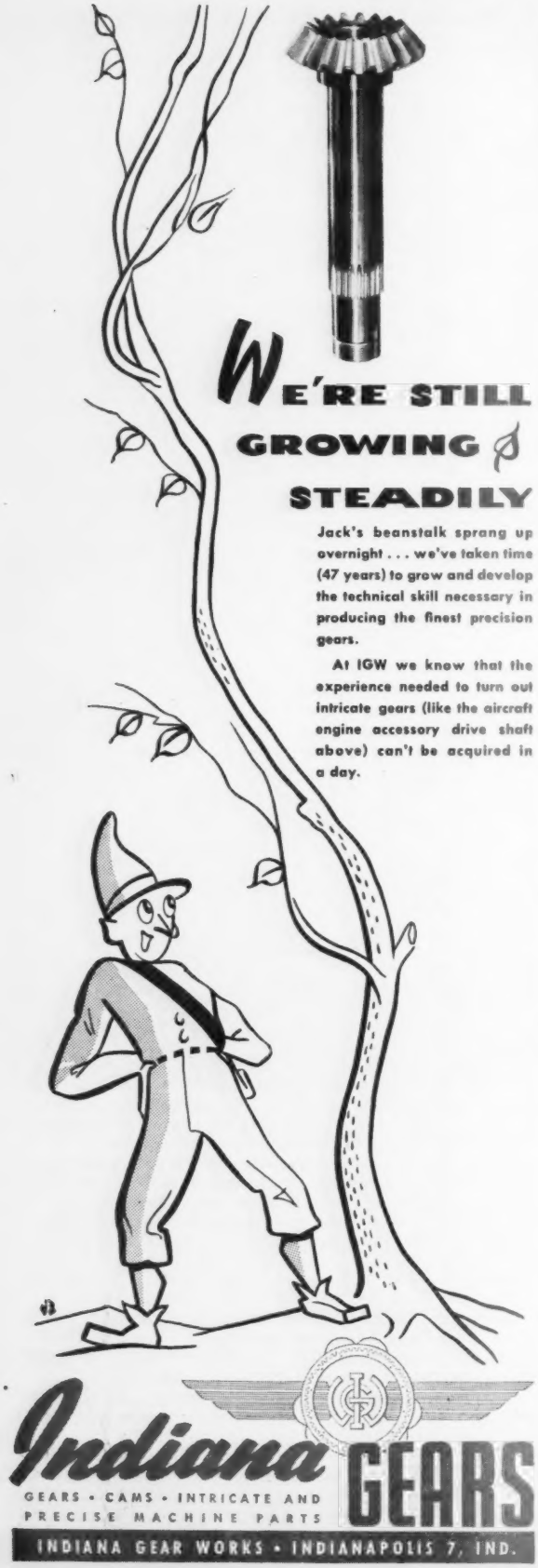
Hispano Suiza 12B. *Flight*, Vol. 56, No. 2120, August 11, 1949, pp. 161, 162, illus., diagrs.

Engine Analyzer. *The Sperry Corp., Sperry Gyroscope Co., Publication No. 15-45C*, May, 1949. 15 pp., illus., diagrs.

Combination of Reciprocating and Turbojet Engines in Me-264 Bomber. Huber and von Stotzingen. (*München, BMW/EZS/Re/32*, November, 1942.) *U.S., Air Force, Translation No. F-TS-1566-RE*, March, 1948. 10 pp., figs.

Description of German Fuel-Injection Systems. E. H. Little and D. E. Danielson. *U.S., Air Force, Summary Report No. F-S U-1105-ND*, September, 1947. 114 pp., figs.

This report outlines general engineering information regarding the history and development of German fuel-injection systems and associated equipment as used on the more successful German aircraft engines. Recommendations by qualified German engineers, relative to proper approach for future investigation, are also contained herein.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JET & TURBINE (5)

A New High-Performance Engine Indicator of the Strain-Gage Type. C. S. Draper and Y. T. Li. *Journal of the Aeronautical Sciences*, Vol. 16, No. 10, October, 1949, pp. 593–610, diagrs., figs. 58 references.

Pressure changes in the working fluid largely determine the performance of heat engines. For this reason, accurate pressure indications are of primary importance for studies of engine operation. Pressure indicators have been in use for many years, but performance defects have restricted their value even for laboratory and test-stand work. The operating limitations have been due to the fact that available pressure receivers have been sensitive not only to pressure but also to temperature, to mechanical strains due to mounting effects, and to mechanical vibrations in the walls of the pressure chamber. It is the purpose of the paper to describe the features of a new pressure receiver using a high-flexibility catenary-type diaphragm and a temperature-compensating wire-wound gage to give satisfactory pressure-measuring characteristics with greatly reduced response to temperature and extraneous mechanical effects.

Controllability of Gas Turbines. E. R. G. Eckert. *U.S., Air Force, Technical Report No. F-TR-2157-ND*, October, 1947. 46 pp., figs.

The behavior of gas turbines at partial load and the different possibilities for their control are studied by superimposing the operating-characteristic diagrams of the compressor and of the turbine. Operating conditions for minimum fuel consumption and maximum output at various flying conditions can be traced easily in this way. Any of the various types of propulsion units for airplanes using gas turbines—the gas turbojet, propjet and jet with thrust augmentation by a blower, all with or without heat exchanger, have different demands for an optimum control. These are investigated in detail. This report thus presents the basic demands which the controlling devices must fulfill.

Analysis of German Propeller-Turbine Power-Plant Designs. Bruno W. Bruckmann, Peter G. Kappus and Franz Huber. *U.S., Air Force, Technical Report No. F-TR-2162-ND*, October, 1947. 27 pp., diagrs.

Based on German wartime experience on aircraft gas turbines, a general survey is presented on various gas-turbine type power-plant designs. Results of principal thermodynamical calculations are dealt with to illustrate the influence of compressor pressure ratio and turbine inlet temperature. Estimation of weights for the different types and calculations of obtainable ranges are included. The performance calculations are presented graphically. The various configurations of suggested power-plant layouts are illustrated on schematic diagrams.

Momentum Measurement by Balancing an Impact Plate Pendulum and Suggestion of Applications to Jet Engines. S. H. Hasinger and W. T. von der Nuell. *U.S., Air Force, Technical Report No. F-TR-2163-ND*, February, 1948. 13 pp., figs.

Propulsive units based on gas- or air-jets have recently attained major significance for aircraft. An accurate and rapid measuring method for determining their thrust is of great importance. The impact-plates pendulum is recommended by the authors for thrust measurement. Experiments have proved that this method is simple and satisfactory, provided some special experiences are taken into account. Furthermore, impact bodies offer possibilities for testing turbojet units and probably also rocket power plants without removing regular airplane mountings. Schematic arrangements are suggested. This report discloses basic ideas, experiments, and experiences.

Generalization of Turbojet-Engine Performance in Terms of Pumping Characteristics. Newell D. Sanders and Michael Behun. *U.S., N.A.C.A., Technical Note No. 1927*, August, 1949. 33 pp., diagrs., figs. 4 references.

Characteristics of a basic turbojet engine consisting of compressor, combustor, and turbine presented in terms of corrected air flow, ratio of engine-outlet to -inlet total pressure, ratio of engine-outlet to -inlet total temperature, Reynolds Number index, corrected engine speed, and corrected fuel-air ratio. The presentation describes the engine independently of the characteristics of other elements of the propulsion system and permits rapid estimation of performance of complex propulsive systems involving the basic turbojet engine.

Hot-Spin Tests of Bladed Jet-Engine Rotors. H. B. Saldin and P. G. DeHuff, Jr. *American Society of Mechanical Engineers, Transactions*, Vol. 71, No. 6, August, 1949, pp. 605–612, illus., diagr., figs. 5 references.

The creep-rupture and ductility characteristics of materials are of utmost importance to the designer of high-temperature rotating parts. Four-bladed discs were tested in a facility that was designed to spin the rotors in as near engine operating conditions as possible. These parts were tested in accordance with a predetermined schedule of temperature gradient, temperature, and speed. Test results are analyzed, and a discussion of the advantages and the design of such a facility is also included.

Thrust Augmentation in Turbojets. H. Oestrich. *Interavia*, Vol. 4, No. 8, August, 1949, pp. 484–488, illus., diagrs., figs.

Internally cooled hollow turbine blades, cooling by water or water-methanol injection, afterburning, adjustable tail cones, and various combinations of these methods give increased thrust ranging from about 20 per cent to 90 per cent. Gas temperatures range from 750°C. to 1,500°C. and fuel consumption increases to as much as 650 per cent of the figure for no thrust-augmentation equipment. Several methods for installing the necessary equipment are described.

The Radial Turbine. Werner T. von der Nuell. *U.S., Air Force, Technical Report No. F-TR-2149-ND*, January, 1948. 67 pp., figs.

Radial and axial gas turbines are compared. Despite the predominance of the axial-flow type, especially for smaller installations such as auxiliary power plants, power units for guided missiles, turbosuperchargers, and other uses, the inward-flow radial, or centripetal turbine offers considerable advantages. The outward-flow radial, or centrifugal turbine will probably have only limited applications as compared with the centripetal type, but a combination of the two types may be advisable, such as a two-stage turbine in which heat losses would be smaller, and bearing temperature would be lower. A further possibility entails the mounting of the two impellers on separate shafts, one to drive the compressor and the other for the useful output. Experiments with a supercharger used as an air turbine are described.

La Turbina a Gas (The Gas Turbine). Antonio Capetti. (*Rivista La "Termotecnica," No. 2, March–April, pp. 62–72, illus., diagrs., figs.*) *Turin, Politecnico, Laboratorio di Aeronautica, Pubblicazione No. 204.* (Parallel English and Italian texts.) (Reprint.)

The Avro Chinook; Canada's First Jet Engine. *The Engineering Journal*, Vol. 32, No. 7, July, 1949, p. 412, illus.

Turboprop Tested in Flying Lab. R. R. Templeton and M. P. Cervino. *SAE Journal*, Vol. 57, No. 8, August, 1949, pp. 52–55, illus., diagrs. (Extended summary of a paper: Flight Testing the Wright Typhoon Turboprop.)

Jets, Turbines, Demand New Forging Methods. L. S. Fulton. *SAE Journal*, Vol. 57, No. 8, August, 1949, p. 67, tables. (Extended summary of a paper.)

Armstrong Siddeley "Python" Gas Turbine Propeller Engine. *The Engineer*, Vol. 188, No. 4882, August 19, 1949, pp. 195–197, illus.

The Use of the p-V-Diagram for Ramjet Calculations. E. R. G. Eckert. *U.S., Air Force, Technical Report No. F-TR-2158-ND*, September, 1947. 15 pp., figs.

Project Squid; The Story of New York University's Contribution to the Nation's Quest for Basic Knowledge of the Pulse-Jet Engine. George E. Hudson. *New York University, College of Engineering, Quadrangle*, April, 1949. 4 pp., illus. (Reprint.)

Cooling by Forcing a Fluid Through a Porous Plate in Contact With a Hot Gas Stream. Max Jakob and I. B. Fieldhouse. *Heat Transfer and Fluid Mechanics Institute, University of California, Berkeley, Calif.*, June 22–24, 1949, pp. 191–200, diagrs., figs. 2 references. American Society of Mechanical Engineers, New York. $5.00.

Lubricating Problems of the Gas Turbine Engine. J. G. Dawson. *Shell Aviation News*, No. 133, July, 1949, pp. 14–22, figs.

General Electric J-47 Gas Turbine. *Shell Aviation News*, No. 133, July, 1949, pp. 12, 13, illus.

Turbines Take to the Air. Howard Mehr. *Aviation Operations*, Vol. 12, No. 2, August, 1949, pp. 29–31, 63–65, illus., diagrs.

Introduction to Ramjet Propulsion. J. P. Field. *Antiaircraft Journal*, Vol. 92, No. 4, July–August, 1949, pp. 15–22, illus., diagrs. Elementary explanation of ramjet propulsion principles, and a discussion of their military applications, limitations, and problems involved.

Bristol Proteus; A High-Compression Turboprop for Wing Mounting. *Flight*, Vol. 56, No. 2121, August 18, 1949, pp. 191–196, illus., diagrs., figs., cutaway drawing.

The Gipsy Major—Another Step Forward; First Details of the Major 10 Mark 2. *de Havilland Gazette*, No. 51, June, 1949, p. 2, diagr.

Jubilee of Metropolitan-Vickers; Electrical Engineering to Gas Turbines. *Modern Transport*, Vol. 61, No. 1580, July 9, 1949, pp. 13, 14, illus.

Double Turboprop Engine Built in Britain; Armstrong Siddeley Gears Two Mambas to Coaxial Contrarotating Propellers to Develop Peak of 3,500 Hp. *Aviation Week*, Vol. 51, No. 3, July 18, 1949, pp. 21, 22, illus., diagrs.

Spark-Timing Control Based on Correlation of Maximum-Economy Spark Timing, Flame-Front Travel, and Cylinder-Pressure Rise. Harvey A. Cook, Orville H. Heinicke, and William H. Haynie. *U.S., N.A.C.A., Report No. 886*, 1947. 6 pp., illus., figs. 2 references. U.S. Govt. Printing Office, Washington. $0.10.

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The Development of Turbine Engines in France; An Account of Some of the Experimental Work Carried Out by the Research Departments of the Société Rateau at La Courneuve. (*Bulletin Technique Rateau, No. 170, 1948, No. 2, pp. 4–27.*) *Aircraft Engineering*, Vol. 21, No. 246, August, 1949, pp. 244–247, figs.

An American Gas Turbine of Low Power; A Unit Developed Experimentally by the Boeing Airplane Company for Study and Investigation. H. W. Perry. *Aircraft Engineering*, Vol. 21, No. 246, August, 1949, pp. 242, 243, 263, figs.

The Silencing of Test Houses for Turbo-Jet Engines; An Account of the Problems Involved and the Means by Which They Have Been Overcome in a New French Installation. A. de Rosen. *Aircraft Engineering*, Vol. 21, No. 246, August, 1949, pp. 236–241, figs. 7 references.

Jet Thrust Measured on Ground; Floating Platform, "Thrustorq" Unit. *Aviation Week*, Vol. 51, No. 8, August 22, 1949, pp. 26, 27, illus., diagr.

Turbines et Turbo-Réacteurs Français (French Turbines and Turbojets). C. Martinot-Lagarde. *L'Air*, Vol. 30, No. 630, August, 1949, pp. 10, 11, illus.

Le Leduc 0.10 (Pulsejet). R. Lacombe. *L'Air*, Vol. 30, No. 629, p. 11, illus., diagrs.

Don't Write Off the Centrifugal Compressor. W. P. Dunphy. *Aircraft and Airport*, Vol. 11, No. 8, August, 1949, pp. 10–12, diagr.

RECIPROCATING (6)

Shock in Valve Mechanisms of Internal Combustion Engines. Jaroslav Miksch. *Aircraft Engineering*, Vol. 21, No. 245, July, 1949, pp. 222–226, figs.

Mathematical analyses of the stresses acting on poppet valve mechanisms and of the motions resulting from the forces involved are applied, in a practical example, to the computation of the shock and the effects of speed variation, valve clearance, valve mass, cam-shaft inertia, cam acceleration, cam elasticity, and other factors, on the maximum stress.

Observation of the Lubricating Oil Film Between Piston Ring and Cylinder of a Running Engine; The Effects of Lubricant Properties and Additives. R. L. Brooks and M. L. Atkin. *Australia, Council for Aeronautics, Report ACA-42*, September, 1948. 13 pp., illus. 5 references.

The effect of various oils and additives on lubrication is studied by measurement of the electrical contact resistance. Physical rather than chemical factors determine the breakdown of the oil film.

Application des Équations de Lagrange au Calcul des Forces de Liaison dans les Moteurs en Étoile (Application of the Lagrange Equations to the Calculation of the Force Couples in Radial Engines). B. Fraeys de Veubeke. *Belgium, L'Académie Royale, Bulletin du Service Technique de L'Aéronautique, No. 22*, January, 1949. 58 pp., diagrs., figs. 19 references.

Über den Einfluss der Exzentrischen Anlenkung der Pleuelstangen in Verbrennungsmotoren (The Effect of the Eccentric Linkage of the Piston Rods in Internal Combustion Engines). Henrik Ryti. *Finland, Valtion Teknillen Tutkimuslaitos, Statens Tekniska Forskningsanstalt, Julkaisu Publication No. 4*, 1948. 117 pp., diagrs., figs. 37 references. (In German.)

Power for the Brabazon; Four Twin Centaurus Units Develop 20,000 H.P. *Shell Aviation News*, No. 133, July, 1949, pp. 7–9, illus.

ROCKET (4)

Turbopump Assembly for HWK 109-509 Rocket Motor. R. F. Gompertz. *U.S., Air Force, Interim Report No. F-IM-2127-ND*, February, 1948. 34 pp., figs.

Fuel pumps driven by a steam turbine using gas and superheated steam. Units were manufactured by Bruckner-Kanis for the HWK 109-509 rocket power plant.

Rocket Engine 109-548 For X-4 Guided Missile. Gartmann. (*Berlin, Spandau, BMW Flugmotorenbau, G.m.b.H., BMW/ERZ-1/44*, March, 1944.) *U.S., Air Force, Translation No. F-TS-2747-RE*, July, 1947. 7 pp., figs.

Principle of operation of 109-548 rocket motor, also known as P-3378, is discussed. The unit uses self-reacting propellants delivered by compressed air. Description of combustion chamber, tanks, propellant feed system, air release valves and diaphragm seals. Data on design specifications and performance are given. Instructions have been prepared for preflight maintenance.

Measurements Taken on the 109-548 Rocket Engine. Ristau. (*Spandau, BMW Flugmotorenbau G.m.b.H., BMW/ERZ-2/44*, March, 1944.) *U.S. Air Force, Translation No. F-TS-2752-RE*, October, 1947. 10 pp., diagrs.

Production (36)

Lower Cost Aluminum Die Castings Possible Through Use of Scrap Metal. James H. Hamnett. *Materials & Methods*, Vol. 30, No. 2, August, 1949, pp. 72–74, illus.

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Testing for Cockpit Leaks. Gilbert C. Close. *Aviation Operations*, Vol. 12, No. 2, August, 1949, pp. 46, 69, illus.

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Propellers (11)

The Design of Propellers. G. C. I. Gardiner and J. Mullin. *Royal Aeronautical Society, Journal*, Vol. 53, No. 464, August, 1949, pp. 745–762, diagrs., figs. 5 references.

From the standpoint of practical design problems of hydraulically operated propellers for transport aircraft, it is more important to obtain strictly comparable performance data from all possible sources than to know the absolute value of propeller efficiency. "Induced efficiency" at a given operating condition is mainly a function of disc loading, and it falls as the loading increases. "Profile efficiency" is primarily affected by the lift-drag ratio of the blades, which is controlled by the blade incidence and area. The final determination of diameter is a matter of compromise, and severe diameter limitations can be expected to result in loss of thrust efficiency, increase in noise level, and greater weight. Higher disc loading can be employed with increased aircraft speed and range. Blade area, number of blades, airfoil section, and deicing devices also call for compromise resulting in efficiency losses ranging from 1 to about 4 per cent. Propeller weight must be kept within limitations determined by these factors. Practical experience in standardization shows that the limiting blade diameter for a given root diameter is smaller than indicated by theory. Steady-stress magnitude can be accurately determined, and present safety factors could be substantially reduced if there were better methods of computing vibratory and fatigue stresses. The choice of material is determined by the stiffness, weight ratio, resistance to fatigue and erosion, and ease of repair, on which bases wood, aluminum alloys, and steel are found suitable for specific requirements, but magnesium is rejected. Future large propellers will be self-contained units with their own oil supply, eliminating the difficulties experienced through the use of the engine-lubricating system.

The Design of Propellers. G. C. I. Gardiner and J. Mullin. *de Havilland Gazette*, No. 51, June, 1949, pp. 12–17, diagrs. (Extended summary of a paper.)

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They've Done Something About Weather, 3,000,000 Cubic Feet of it, Anyway; At Elgin Air Force Base. *The Martin Star*, Vol. 8, No. 8, August, 1949, pp. 13–17, 26, illus.

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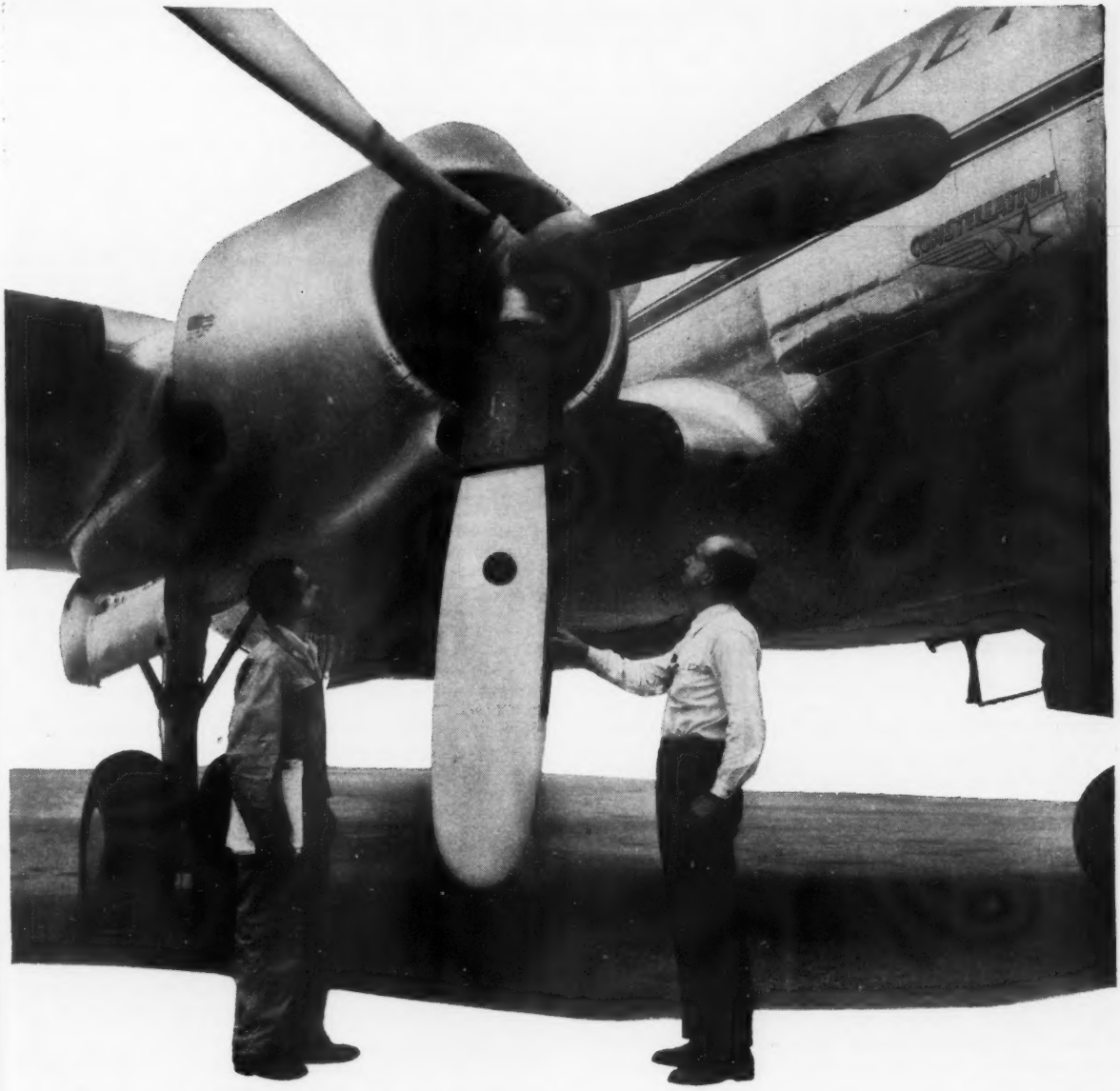

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The Gyrodyne. J. A. J. Bennett. *American Helicopter Society, Inc., Fourth Annual Forum, Philadelphia, Proceedings,* April 22–24, 1948. 8 pp., illus., diagrs. $6.00.

Helicopter Development at Bristol Aircraft. Raoul Hafner. *American Helicopter Society, Inc., Fourth Annual Forum, Philadelphia, Proceedings,* April 22–24, 1948. 7 pp., illus. $6.00.

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Electronic Equipment for a Helicopter Testing Tower. *Electronic Engineering,* Vol. 21, No. 258, August, 1949, pp. 292, 293, illus.

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MECHANICS

Sur l'Accélération du Second Ordre (Second Order Acceleration). S. Trailescu. *Timişoara (Rumania), L'École Polytechnique, Bulletin de Science et Technique,* Vol. 13, Fasc. 3, 1948, pp 239–245.

OPTICS

Optical Algebra. Nathan Grier Parke, III. *Journal of Mathematics and Physics,* Vol. 28, No. 2, July, 1949, pp. 131–139, figs. 5 references.

Structures (7)

A Modification of the Holzer Method for Computing Uncoupled Torsion and Bending Modes. Henry E. Fettis. *Journal of the Aeronautical Sciences,* Vol. 16, No. 10, October, 1949, pp. 625–634, figs. 7 references.

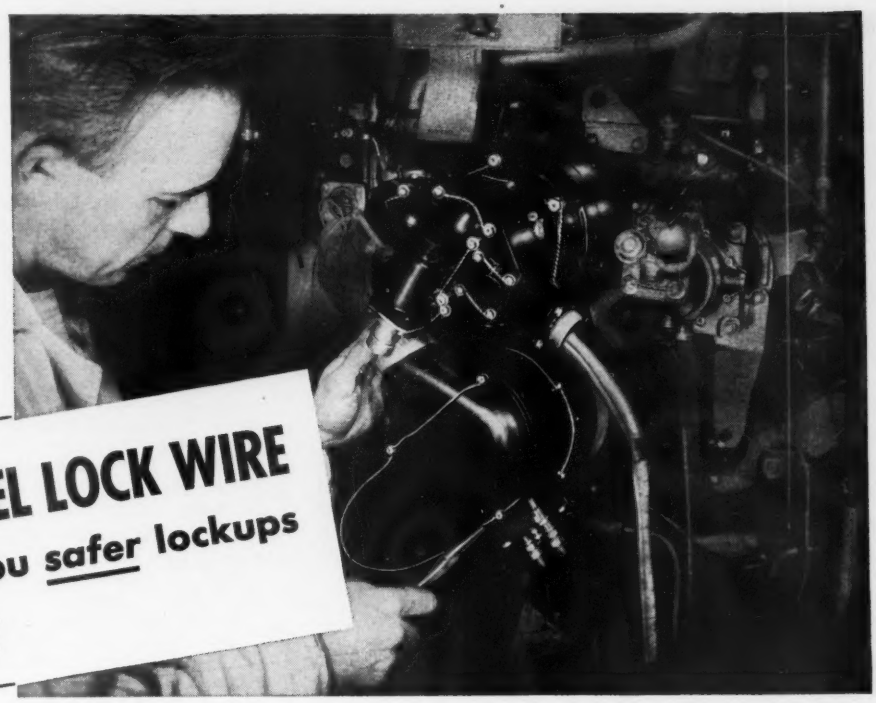
An adaptation of the process devised by Holzer for solving the differential equations of beam vibrations. Its original form is usually employed in computing the torsional modes of vibration of a bar carrying a series of concentrated discs. Similar processes were devised by Myklestad and Bellin for bending modes, and recently an extension of the above principle to the computation of coupled modes has been published. All of the methods have in common the feature that a value of frequency is assumed and a deflection computed which satisfies all but one of the required end conditions. Although the same principle forms the basis for the following method, the system of numerical integration employed makes the method better suited to configurations with continuous mass and stiffness distributions. The process is set up in such a manner as to be easily adapted to routine calculation by a semiskilled computer and the correctness of the results may be verified at each station. All of the features that make the Holzer method practical are retained, and some new techniques not in common use are introduced.

Simplified Analysis of General Instability of Stiffened Shells in Pure Bending. F. R. Shanley. *Journal of the Aeronautical Sciences,* Vol. 16, No. 10, October, 1949, pp. 590–592, figs. 6 references.

Although much work has been done to develop a theory for the failure of shells by general instability, there is at present no simple method by which the size of the frames may be determined for any given diameter, bending moment, and frame spacing. Such a method is needed in determining the optimum design for stiffened shells, to be used as a basis for weight analysis of fuselage, and other shell structures. In an extension of the work done for The RAND Corporation, a simple coefficient has been determined for this purpose. Since it appears that this method may also be useful in design calculations, a brief description is presented below.

Graphical Analysis of Impact of Bars Stressed Above the Elastic Range. II—Impact in the Stress Range Above the Elastic Limit. Kalman J. DeJuhasz. *Franklin Institute, Journal,* Vol. 248, No. 2, August, 1949, pp. 113–142, figs. 43 references.

Continuation of a discussion of the stress-strain relationship. It has been found that the elastic modulus is constant below the elastic limit, at which stress the value of the elastic modulus undergoes a sudden decrease to a new value which continues to decrease gradually under increasing stress. Upon unloading the stress, however, the initial elastic modulus is valid and, furthermore, when a new elastic limit is established, the reapplication of stress will cause the material to follow the elastic modulus lineup until the new value is attained. In accordance with these characteristics the velocity of propagation and the wave factor undergo first a sudden and then a gradual decrease in stress range above the elastic limit. With the aid of curves and diagrams the change of state in a bar of annealed copper can be followed in a manner



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similar to that for other examples of elastic impact. Results are summarized as follows: In the stress range below the elastic limit, the velocity of propagation and the wave factor are constants. At the elastic limit, both the velocity of propagation and the wave factor undergo a sudden decrease to new values. Above the elastic limit, the velocity of propagation and the wave factor change gradually in a manner corresponding to the change of the square root elastic modulus. The velocity of propagation and the wave factor are proportional for any stress value. Application of these principles is illustrated by several examples.

Stress-Strain Relations in the Plastic Range for Biaxial Stresses. Joseph Marin. *Franklin Institute, Journal,* Vol. 248, No. 3, September, 1949, pp. 231–249, illus., diagrs., figs. 14 references.

This paper gives the results of an experimental investigation on thin-walled aluminum alloy tubes subjected to combined tension and torsion. A specially designed testing machine was constructed for obtaining plastic load-strain relations to rupture for various ratios of the principal stresses ranging from 0 to —1.0. During each test, the ratios of the principal stresses were maintained essentially constant. Nominal stress-strain diagrams for the elastic range and true stress-strain diagrams for the plastic range were plotted for each test and each stress ratio. Values of yield strength, ultimate strength, fracture strength, ductility, and plastic stress-strain relations for the various biaxial stress ratios investigated were compared with theoretical values based upon uniaxial tension results. The yield strength values were found to be in good agreement with values predicted by the Von Mises-Hencky Distortion Energy Theory. The nominal ultimate strengths, fracture strengths, ductility, and plastic stress-strain relations were approximately in agreement with the values predicted by the distortion energy theory using St. Venant's plasticity relations.

Fatigue of Aircraft Structures. P. B. Walker. *Royal Aeronautical Society, Journal,* Vol. 53, No. 464, August, 1949, pp. 763–778, Discussion, pp. 778–796, figs.

Structural fatigue may become a third major factor in design in addition to the two criteria of static strength and stiffness. Aircraft fatigue is more comprehensive than in the classical concept, since fluctuations in the entire load system must be considered because of the light materials and construction used and because of the great variations of applied load resulting from gusts and air turbulence. The substance of empirical testing theory can be incorporated in a master diagram that covers possible variations of endurance and loading. Riveted joints and other structural elements may show fatigue properties inferior to those deduced from considerations of material properties alone, largely because of stress concentrations. In addition to the fatigue characteristics of the structure and the fluctuating loads encountered, the designer must consider the working life of the aircraft, which is being limited by obsolescence and economic factors. Only sufficient fatigue resistance need be incorporated in the design so that fatigue failure may not occur within the normal service life of the aircraft. Fatigue failure may not necessarily result in accidents and is frequently detected by inspection. Future design trends may involve a search for materials offering the fatigue-resisting properties of steel without excessive weight penalties, and improved methods of "gluing" metals as a substitute for riveting.

Sur l'Existence de la Solution d'un Problème d'Elasticité (On the Existence of a Solution to a Problem of Elasticity). Cahit Arf. *L' Université d'Istanbul, La Faculté des Sciences, Revue, Serie A: Mathematiques, Physique, Chimie,* Vol. No. 14, Fasicule 2, April, 1949, pp. 75–85. (In French.)

Undercarriage Test. C. G. Longford. *Hawker Siddeley Review,* Vol. 2, No. 2, June, 1949, pp. 6–13, illus., diagrs., figs.

Aircraft Static Test Equipment. W. J. Cox. *Quarterly Bulletin, Aeronautical Laboratories, National Research Council of Canada, Report No. ME 1949 (2),* April 1–June 30, 1949, pp. 1–4, illus., fig. Description of the installation and operation of hydraulic static-testing equipment of the Structures Laboratory of the Mechanical Engineering Division. Aircraft wings up to about 120 ft. span, and other large structures can be accommodated.

The Elementary Theory of Stressed-Skin Construction. III. IV. W. S. Hemp. *Aircraft Engineering,* Vol. 21, No. 245, July, 1949, pp. 227–230.

Sul Calcolo delle Strutture a Guscio (The Stress Analysis of Semimonocoque Structures). P. Cicala. *Turin, Politecnico, Laboratorio di Aeronautica, Pubblicazione No. 200.* 52 pp., figs. 12 references. (English résumé included.)

The Elementary Theory of Stressed-Skin Construction; Two Further Installments of a Series on the Stressing of Modern Aeroplane Structures. (Conclusion.) W. S. Hemp, M. A. *Aircraft Engineering,* Vol. 21, No. 246, August, 1949, pp. 248–251.

Dynamic Loads on Airplane Structures. E. S. Jenkins and C. D. P. Pancu. *SAE Quarterly Transactions,* Vol. 3, No. 3, July, 1949, pp. 391–409, figs. 49 references. (See Aeronautical Engineering Index, 1948, p. 213.)

Recenti Ricerche sulle Vibrazioni Alari (Recent Research on the Vibration of Wings). P. Cicala. *(L'Aerotecnica, Vol. 27, Fasc. 1, 1947, pp. 149–162. 30 references.) Turino, Politecnico, Laboratorio di Aeronautica, Pubblicazione No. 202.* (Reprint.)

Appraisal of Method of Flutter Analysis Based on Chosen Modes by Comparison with Experiment for Cases of Large Mass Coupling. Donald S. Woolston and Harry L. Runyan. *U.S., N.A.C.A., Technical Note No. 1902,* June, 1949. 16 pp., figs. 12 references.

Results are presented for a series of flutter studies in which a Rayleigh type analysis based on chosen modes is applied to a uniform model wing carrying an arbitrarily placed concentrated weight in order to appraise the accuracy of the assumption of uncoupled modes of vibration. The results are compared with experiment.

A Flight Investigation of the Effects of Compressibility on Applied Gust Loads. E. T. Binckley and Jack Funk. *U.S., N.A.C.A., Technical Note No. 1937,* August, 1949. 22 pp., diagrs., figs. 3 references.

The jet-propelled airplanes were flown at different speeds in rough air to investigate the effects of compressibility on applied gust loads. Data were obtained over a Mach Number range of 0.25 to 0.68 for effective gust velocities up to 15 ft. per sec. An analysis of the results indicated that no compressibility correction to the slope of the lift curve was necessary up to a Mach Number of 0.68 for gust velocities up to 9 ft. per sec. Data obtained for gust velocities greater than 9 ft. per sec. were insufficient for analysis.

The Buckling in Compression of Panels with Square Top-Hat Section Stringers. W. S. Hemp and K. H. Griffin. *College of Aeronautics, Cranfield, England, Report No. 29,* June, 1949. 18 pp., figs. 2 references.

Simplified panel models consisting of stringer-skin combinations with cross sections perpendicular to the direction of the stringers were tested for buckling under the action of compressive stress parallel to the direction of the stringers. The calculation was approached by dividing the panel into a number of flat plates and treating these by the ordinary plate theory. Use of the boundary conditions between the plates led to a relation between the buckling stress and the variables of the panel geometry. Results thus obtained show substantial agreement with two recent examples of experimental work.

The Determination of Redundant Constraints in Beams; A Simple Statement, with Proofs, of Formulae for the Three Principal Cases. F. E. S. Manton, B.Sc., A.C.G.I. *Aircraft Engineering,* Vol. 21, No. 246, August, 1949, pp. 252–254, figs.

A Note on Analysis of Beam-Columns Under Arbitrary Lateral Load and End Restraint. R. H. Scanlan. *Franklin Institute, Journal,* Vol. 248, No. 2, August, 1949, pp. 143–153, figs. 5 references.

A general mathematical method of solution for long constant-section beam columns with elastically restrained ends and arbitrary lateral loads. By converting the integrals that are developed into sums, tables for practical calculation can easily be set up. The method outlined agrees well with analytical results and is not made more difficult by complex loading.

Critical Combinations of Shear and Direct Axial Stress for Curved Rectangular Panels. Murry Schildcrout and Manuel Stein. *U.S., N.A.C.A., Technical Note No. 1928,* August, 1949. 29 pp., figs. 9 references.

A solution for the problem of the buckling of curved rectangular panels subjected to combined shear and direct axial stress. Charts giving theoretical critical combinations of shear and direct axial stress are presented for panels having five different length-width ratios. Because the actual critical compressive stress of rectangular panels with substantial curvature is known to be much lower than the theoretical value, a semiempirical method of analysis of curved panels subjected to combined shear and direct axial stress is presented for use in design.

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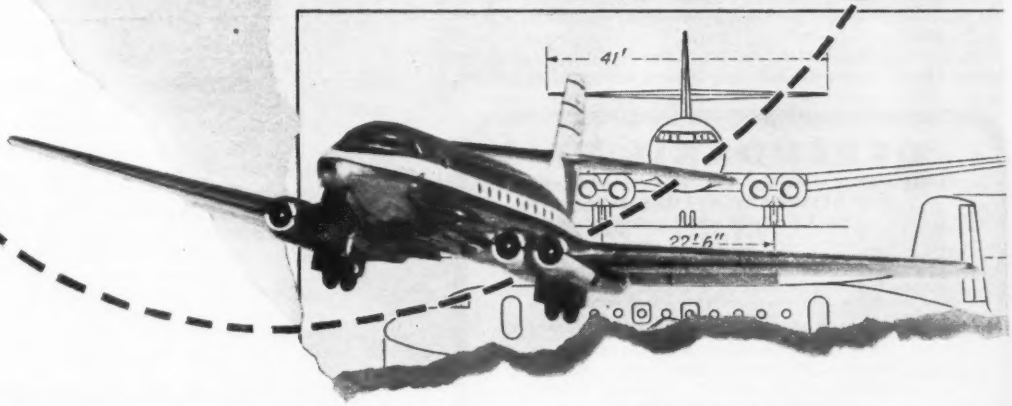

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Calculating Stresses and Deflections in Circular Plates. William A. Nash. *Machine Design*, Vol. 21, No. 8, August, 1949, pp. 149, 150, figs.

Effect of Transverse Shear and Rotary Inertia on the Natural Frequency of a Uniform Beam. Edwin T. Kruszewski. *U.S., N.A.C.A., Technical Note No. 1909*, July, 1949. 15 pp., figs. 2 references.

Theoretical derivations of the effect of transverse shear and rotary inertia on the frequencies of a uniform beam. Solutions of the frequency equations are presented in the form of charts for the first three modes of the cantilever beam and the first six modes of the free-free beam.

Letter Symbols for Structural Analysis, American Standard. *Sectional Committee on Letter Symbols and Abbreviations for Science and Industry. American Society of Mechanical Engineers Standard No. ASA Z10.8-1949*, May, 1949. 7 pp.

Critical Stress of Thin-Walled Cylinders in Axial Compression. S. B. Batdorf, Murry Schildcrout, and Manuel Stein. *U.S., N.A.C.A., Report No. 887*, 1947. 8 pp., figs. 15 references. U.S. Govt. Printing Office, Washington. $0.10.

Matrix Solution of the *n*-Section Column. William T. Thomson. *Journal of the Aeronautical Sciences*, Vol. 16, No. 10, October, 1949, pp. 623, 624, fig. 1 reference.

A procedure is developed for the determination of the critical load of a column of "*n*" different sections under any end conditions. When "*n*" is a small number, the method leads to simple analytic expressions for the critical load.

Bepaling van den Theoretischen Kniklast van Constructies uit Experimenteele Waarnemingen (The Determination of the Theoretical Buckling Load of Structural Members From Experimental Data). F. J. Plantema and I. Binkhorst. *Netherlands, Nationaal Luchtvaartlaboratorium, Amsterdam, Rapport Nr. S.260*, March 15, 1942. 24 pp., diagrs., figs. 14 references. (In Dutch.)

On the Effective Width of Reinforced Plane Plates. Folke Odqvist. (*Teknisk Tidskrift, No. 16, 1942.*) *Royal Swedish Air Board, Translation No. 5*, 1948. 24 pp., diagrs., figs. 8 references. (In English.)

An Experimental Determination of the Fatigue Diagram for Alclad Sheet Specimens with Rivet Holes, Subjected to Tension and Compression. G. Wallgren. (*Sweden, Aeronautical Research Institute, Report No. 14*, July, 1945.) *Royal Swedish Air Board, Translation No. 9*, 1948. 12 pp., diagrs., figs. 4 references. (In English.)

An Experimental Determination of the Fatigue Diagram for Tension and Compression in Alclad Sheet. S. Luthander and G. Wallgren. (*Sweden, The Aeronautical Research Institute, Report No. 5.*) *Royal Swedish Air Board, Translation No. 8*, 1948. 11 pp., diagrs., figs. (In English.)

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Thermodynamics (18)

Heat Transfer Coefficients in Beds of Moving Solids. O. Levenspiel and J. S. Walton. *Heat Transfer and Fluid Mechanics Institute, University of California, Berkeley, Calif.*, June 22–24, 1949, pp. 139–146, diagrs., figs. 27 references. American Society of Mechanical Engineers, New York. $5.00.

The Thermodynamics of Flow Systems. Charles F. Curtiss and Joseph O. Hirschfelder. *University of Wisconsin, Naval Research Laboratory, Department of Chemistry, Report No. CM-544*, May 9, 1949. (Nord 9932, Task WIS-1-C.) 11 pp.

The rate of change of entropy in a flow system is evaluated, explicitly taking into account heat conductivity, viscosity, diffusion, and chemical reactions. The equations are developed rigorously from the kinetic theory of gases.

Pressure Drop and Convective Heat Transfer With Surface Boiling at High Heat Flux: Data for Aniline, N-Butyl Alcohol, and Water. Frank Kreith and Martin Sommerfield. *Heat Transfer and Fluid Mechanics Institute, University of California, Berkeley, Calif.*, June 22–24, 1949, pp. 127–138, diagr., figs. 13 references. American Society of Mechanical Engineers, New York. $5.00.

Photographic Study of Bubble Formation in Heat Transfer to Subcooled Water. Fred C. Gunther and Frank Kreith. *Heat Transfer and Fluid Mechanics Institute, University of California, Berkeley, Calif.*, June 22–24, 1949, pp. 113–126, illus., diagrs., figs. 10 references. American Society of Mechanical Engineers, New York. $5.00.

Heat-Transfer Coefficients and Friction Factors for Air Flowing in a Tube at High Surface Temperatures. Leroy V. Humble, Warren H. Lowdermilk, and Milton D. Grele. *Heat Transfer and Fluid Mechanics Institute, University of California, Berkeley, Calif.*, June 22–24, 1949, pp. 165–180, diagrs., figs. 4 references. American Society of Mechanical Engineers, New York. $5.00.

A Method for Measuring Surface Heat Transfer Using Cyclic Temperature Variations. J. C. Bell and E. F. Katz. *Heat Transfer and Fluid Mechanics Institute, University of California, Berkeley, Calif.*, June 22–24, 1949, pp. 243–254, diagrs. 5 references. American Society of Mechanical Engineers, New York, $5.00.

Water-Borne Aircraft (21)

Tank Investigation of a Powered Dynamic Model of a Large Long-Range Flying Boat. John B. Parkinson, Roland E. Olson, and Marvin I. Haar. *U. S., N.A.C.A., Report No. 870*, 1947. 23 pp., illus., diagrs., figs. 6 references. U.S. Govt. Printing Office, Washington. $0.20.

Tests were made to determine the minimum allowable depth of step for adequate landing stability, the suitability of the fore-and-aft location of the step, the take-off performance, the spray characteristics, and the effects of simple spray-control devices. The test results indicated that: Landing stability was satisfactory with a depth of step of 9 per cent beam at the centroid; the hydrodynamic center-of-gravity range for stable take-offs was satisfactory as to extent and position with respect to the stable flight range desired; the take-off performance was satisfactory for the power loading assumed; the relation of the proportions to the design loading of the hull was correct for satisfactory spray characteristics; and large overloads were possible with relatively simple spray-control devices. The application of the design criterions used and test results should be useful in the preliminary design of similar large flying boats.

Tests of a Flat Bottom Planing Surface to Determine the Inception of Planing. *U.S., Navy Department, Bureau of Aeronautics, Division of Research, DR Report No. 1096*, December, 1948. 16 pp., diagrs. 5 references.

Model Tests on Single-Step Planing Surfaces. Curt Falkemo and Johan Adlercreutz. (*Kungliga Tekniska Hogskolans Handlingar Nr. 24, 1948.*) *Acta Polytechnica, Stockholm, No. 37 (Physics and Applied Mathematics Series, Vol. 1, No. 6)*, 1949. 40 pp., figs. 6 references. Sw. Kr. 3.50.

Study of the forces on flying boat hulls and seaplane floats in the idealized form of two flat planing surfaces meeting at various angles. Longitudinal stability was improved when the planing surface was divided by a transverse step of adequate size. Both drag and stability are affected by the position of the center of pressure on the bottom surface. Where a double planing surface was used, an optimum drag range was determined by the angle of incidence for each velocity under each given load. Reduction in drag was attributed to the shape of the bottom surface, and the speed of advance of the planing surface. The tests suggested the most appropriate shape of the bottom surfaces and the most suitable position of the center of pressure.

Wind Tunnels (17)

Untersuchung von Symmetrischen Traflügelprofilen bei Hohen Unterschallgeschwindigkeiten in Einem Geschlossen Windkanal (Investigation of Symmetrical Airfoil Profiles at High Subsonic Velocities in a Closed Wind Tunnel). Fritz K. Feldmann. *Zürich, Eidgenössischen Technischen Hochschule, Institut für Aerodynamik, Mitteilung Nr. 14.* 70 pp., illus., diagrs., figs. 9 references. Verlag A. G. Gebr. Leemann & Co., Zurich, 1948. 8. Swiss Francs.

Three component measurements of 6 symmetrical profiles; N.A.C.A. 0 0012—1.1–30, 0 0009—1.1–30, 0 0006—0.55–40, 0 0009—0.44–40, and 0 0006—0.55–40; were obtained at a Reynolds Number of 500,000 and the flow was observed by a Schlieren-optic system. By widening the closed wind tunnel locally the deviation of the flow caused by the model-suspension strut was eliminated. Decrease in profile thickness and increase in the distance of maximum thickness from the leading edge, shifted the influence of compressibility on the airfoil characteristics to higher Mach Numbers. The intensity of the compressibility effect decreased with decreasing profile thickness. A method was developed for experimentally determining the corrections required by the solidity of the model itself. When these corrections were calculated for Mach Numbers above critical by the method of B. Gothert and A. Thom the results obtained were smaller than the experimental values.

Industrial Wind Tunnels. D. L. Ellis. *Royal Aeronautical Society, Journal*, Vol. 53, No. 464, August, 1949, pp. 797–818, illus., diagrs., figs.

The most useful tunnel for general purposes has a working section of about 50 to 100 sq.ft. and speed of 200 to 300 ft. per sec., giving a Reynolds Number high enough for reliable stability and control measurements with a model of convenient size. For such work as the determination of the optimum wing-nacelle combination for a given engine, cooling system, and landing gear, a six-component balance is required, giving readings of life, drag, and cross-wind forces, and rolling, pitching, and yawing moments. Pressure plotting is a function whose scope has been extended in recent years to the prediction and prevention of shock stalling at high speeds. A 9- by 7-ft. tunnel, thought to be suitable for industrial use and described in detail, requires 250 hp. to develop speeds of about 200 ft. per sec., and 850 hp. for speeds up to 300 ft. per sec. A new high-speed tunnel recently put into operation is of the simple straight-through type and is powered by a jet engine acting as an ejector pump. The exhaust heat is used to control humidity and prevent condensation in the working section. A Mach Number of 0.9 is reached when the tunnel is empty and over 0.85 with a model in place. The Reynolds Number is 1.6×10^6 for a three-dimensional half model, and 5×10^5 for two-dimensional wings.

Flow Measurement by Means of Light Interference. Th. Zobel. (*ZWB, Forschungsbericht Nr. 1167*, February 1, 1940.) *U.S., N.A.C.A., Technical Memorandum No. 1253*, August, 1949. 58 pp., illus., diagrs., figs. 5 references.

A Mach-Zehnder interferometer was used for making flow measurements in the high-speed wind tunnel of the LFA. Density distributions around models and in boundary layers were determined directly by the interference method. From the density, other flow variables were calculated.

Experiments on an Induction Type High Speed Wind Tunnel Driven by Low Pressure Steam. G. M. Lilley and D. W. Holder. *College of Aeronautics, Cranfield, England, Report No. 24*, March, 1949. 22 pp., diagrs., figs. 11 references.

Dry saturated and slightly superheated steam at pressures up to 120 lbs. per sq.in. absolute was used as the medium for driving a $2^1/_4$-in. diameter tunnel, and produced results comparable with those obtained with compressed air. Mach Numbers up to about 1.7 were attained. An approximate theoretical analysis of the performance of the tunnel was developed.

Transonic-Supersonic Research Tools. *The Pegasus*, Vol. 14, No. 2, August, 1949, pp. 1–5, illus.

Technique for the Optical Measurement of Turbulence in High Speed Flow. Leslie S. G. Kovasznay. *Heat Transfer and Fluid Mechanics Institute, University of California, Berkeley, Calif.*, June 22–24, 1949, pp. 211–222, illus., figs. 6 references. American Society of Mechanical Engineers, New York. $5.00.

First Successful Transonic Tunnel; NACA Research Facility Uses Rotating Arm to Carry Model, Eliminates Troublesome "Choking" Condition. *Aviation Week*, Vol. 51, No. 6, August 8, 1949, p. 26, diagr.

Design and Initial Operation of a Low Density Supersonic Wind Tunnel. S. A. Schaaf, D. O. Horning, and E. D. Kane. *Heat Transfer and Fluid Mechanics Institute, University of California, Berkeley, Calif.*, June 22–24, 1949, pp. 223–242, illus., diagrs., figs. 18 references. American Society of Mechanical Engineers, New York. $5.00.

Theoretical Calculation of the Diffuser Efficiency of Supersonic Wind Tunnels with Free Jet Test Section. Rudolf Hermann. *Heat Transfer and Fluid Mechanics Institute, University of California, Berkeley, Calif.*, June 22–24, 1949, pp. 255–270, diagrs., figs. 10 references. American Society of Mechanical Engineers, New York. $5.00.

Phenomena in Supersonic Diffusers. Heinrich Ramm. *U.S., Air Force, Translation No. F-TR-2175-ND*, November, 1947. 23 pp., figs.

Investigations on Diffuser Efficiency in Supersonic Wind Tunnels. Dr. Lkaus Oswatitsch. (**Göttingen, Kaiser-Wilhelm Institut für Stroemungsforschung, ZWB/PA/201/179.**) *U.S., Air Force, Translation No. F-TS-3242-RE* (ATI No. 20542), July, 1948. 13 pp., figs.

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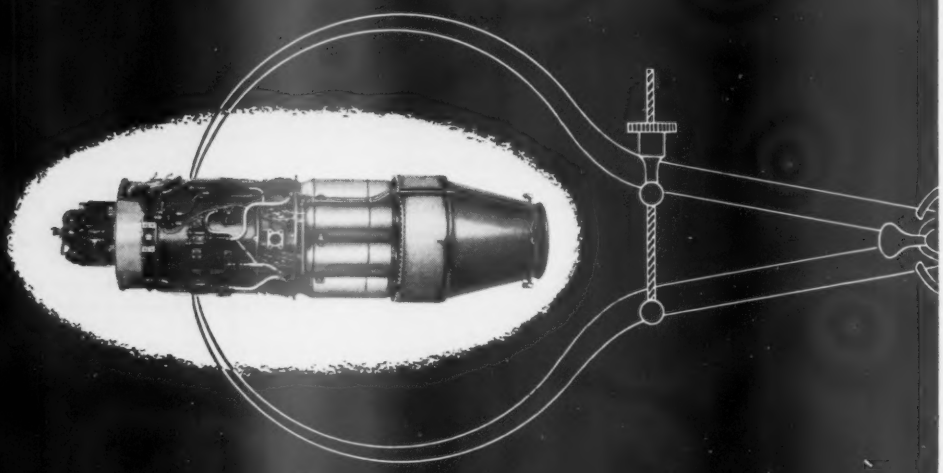

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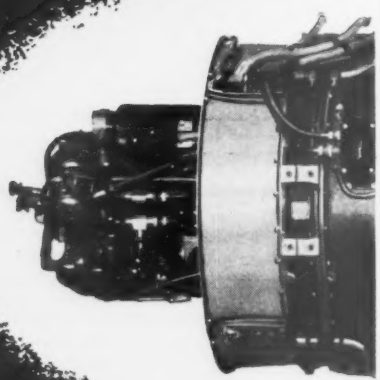

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Books

Scavenging of Two-Stroke Diesel Engines

By Paul H. Schweitzer. New York, The Macmillan Company, 1949. 269 pp., illus. $7.25.

In this book, Professor Schweitzer brings together and attempts to correlate existing theory and practice in the field of two-stroke engine scavenging. The assembling of this material under one cover in itself constitutes a significant contribution, especially so because much of it is from foreign sources not previously available in English translation. The considerable bibliography will also be found extremely useful, both to designers and to research workers in this field. Another excellent feature of the book is the care and completeness with which terms and symbols are defined.

One of the knotty problems in two-stroke engine work is that concerned with exhaust-system pulsations. Professor Schweitzer devotes considerable space to the question, including a whole chapter on the "Kadenacy System." This chapter clears up at least part of the mystery of exactly what constitutes the difference between a Kadenacy engine and any other two-stroke engine.

In his correlation of the assembled material, Professor Schweitzer is handicapped by the fact that basic experimental data concerning the scavenging process are meager and in many cases not convincing. For example, one of the most important quantities that must be dealt with is the one called "scavenging efficiency." The only extensive quantitative data given for this parameter are those of List, obtained in China many years ago with unspecified methods and under unspecified circumstances. Again, in the chapter entitled "Experimental Investigation of Scavenging," the scarcity of experimental results is notable. Another example of uncertain data lies in the evaluation of a "scavenging factor." Here great latitude of choice is allowed, which depends on the designer's judgment, although the number chosen has a most important influence on the resulting design.

In view of the basic uncertainties above noted, the theoretical treatment of the scavenging process, together with the treatment of inlet and exhaust port design, seems to this reviewer somewhat more elaborate than present basic knowledge justifies. In this respect, however, the book performs a valuable service by illustrating the need for additional research on the scavenging process, especially as it is affected by cylinder, piston, and port geometry.

Considering the importance of friction losses on the performance of two-stroke engines, this reviewer found the treatment of the subject disappointingly brief. In Chapter Four, for example, the relationship between scavenging efficiency and brake mean effective pressure involves the assumption of a brake specific fuel consumption, a quantity which is seriously affected by friction characteristics, although this fact is not mentioned in the chapter.

In spite of the defects noted, Professor Schweitzer is to be congratulated on having produced a generally authoritative and useful work. Since most of the discussion does not involve the combustion process, this book will be found valuable not only for the designer of Diesel engines but also for those interested in design and development of two-stroke-spark ignition engines.

PROFESSOR C. FAYETTE TAYLOR
Massachusetts Institute of Technology

Book Notes

AIR TRANSPORTATION

Participation of Water-Borne Carriers in Air Transportation. Merwin Shurberg. (U.S., Library of Congress, Legislative Reference Service, Public Affairs Bulletin No. 68.) Washington, Library of Congress, Card Division, 1949. 52 pp. $0.35. The sea-air policies of the United States and 18 other countries and arguments for and against steamship participation in air transportation are reviewed, with a list of 64 references.

ELECTRONICS

Radio Navigation, Radar and Position Fixing Systems for Use in Marine Navigation. (International Meeting on Radio Aids to Marine Navigation, May, 1946, Vol. II.) London, H.M. Stationery Office; Dallas 1, Texas, P.O. Box 381, Transportation Press, 1946. 190 pp., illus., diagrs. $3.00.

This volume is intended as a precise account of the state of the art. It covers direction-finding systems; hyperbolic navigation, including Loran, Gee, Decca, and the Post Office position indicator; radar; leader cables, allocation of frequencies, transmitting compasses, and charts; technical comparisons of existing systems; and the various frequencies and bandwidths desirable for types of equipment.

For information on I.A.S. Library Service Facilities, see page 39

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FLIGHT SAFETY & RESCUE

Design Manual on Aircraft Fire Protection. Prepared by the Airworthiness Requirements Committee on Powerplant Installations, Aircraft Industries Association. Washington 4, D.C., The Editors of the Aircraft Yearbook, 1949. 20 pp. $1.00.

The purpose of this manual is to present a concise and complete fire-protection background for the designer of transport-category aircraft, with particular reference to the initial stages of design and to foresight of the necessary eventual installation details for fire protection. Cabin, baggage and cargo compartments, and power plant fire protection, including gas-turbine installations, are discussed under five basic divisions: Prevention of Occurrence of Fire, Prevention of Spread of Fire, Fire Detection, Fire Extinguishment, and Ventilation and Smoke Evacuation.

GUIDED MISSILES

Guided Missiles. A. R. Weyl. London, Temple Press, Ltd., 1949. 139 pp., illus., diagrs. 7*s*. 6*d*.

A large part of this book appeared originally in a series of articles in *The Aeroplane*. New material has been added, including an introduction on classes of missiles, their propulsion, stabilization, control, guidance and direction, launching methods, pay loads, and war heads. The origins of guided missiles, V-1, V-2, and smaller types, and the future of missiles in peace and war are among the topics discussed. Tables of design characteristics of about 48 missiles, code names for rocket propellants, and the belligerent use of guided missiles are included.

INDUSTRIAL RELATIONS

Trends in Industrial Relations. Pasadena, Calif., Industrial Relations Section, California Institute of Technology, 1949. 88 pp. $1.00.

The papers printed here were delivered at a conference on "Profitable Personnel Policies," held on the tenth anniversary of the Industrial Relations Section of the California Institute of Technology. Besides reviews of the history of the organization by Lee A. DuBridge, Lawrence A. Appley, and Robert D. Gray, the papers include Management's Responsibilities for Personnel Policies, by Alexander R. Heron; The Labor Outlook, by Leo Wolman; What's Ahead in Industrial Relations, by Lawrence A. Appley; and The Role of Universities in Industrial Relations, by Dale Yoder.

MACHINE ELEMENTS

Unified Screw Threads (With Metric Equivalents). (British Standard No. 1580.) London, British Standards Institution, 1949. 88 pp., diagrs. 7*s*. 6*d*.

This provisional British Standard conforms with the declaration of accord signed in December, 1948, by the United States, Great Britain, and Canada, which agrees a "Unified Screw Thread System." The system at present covers threads 1/4-inch and larger for bolts, nuts, screws, and engineering details and embraces a defined thread form, two regular diameter/pitch series, one coarse and one fine, and the appropriate tolerances for three classes of thread in the regular series and also for threads of special diameters and pitches.

MATERIALS

Engineering Metals and Their Alloys. Carl H. Samans. New York, The Macmillan Company, 1949. 913 pp., illus., diagrs. $7.50.

This text is intended to give a background in production metallurgy, physical metallurgy, or engineering metallurgy of the ferrous and nonferrous metals and their alloys. Over 550 charts diagrams, and microphotographs are included, and the point of view is that of the application of the metal rather than the alloy viewpoint. Footnote references are included throughout, and lists of books and of companies whose bulletins are pertinent are given at the ends of chapters. The author is chief of the metallurgy section of the Research Laboratory, American Optical Company.

Resistance of Materials Laboratory Manual. Urbana, Ill., University of Illinois, Department of Theoretical and Applied Mechanics, 1948. 112 pp., illus., diagrs. $0.50.

Following directions for performing experiments and writing reports, and a brief introduction to the mechanical properties of materials and their determination, the main part of this manual takes up experiments on the failure of materials under static loads, mechanical properties from stress-strain curves, plastic action, and the effect of type of load and test conditions. The procedures for experiments are outlined uniformly and in detail, and a number of illustrations of equipment for testing are included.

MODELS

Model Rockets; Rocket Building for Modelers. George. S. James. Glendale 8, Calif., Reaction Research Division, Rocket Engineering Company, 1948. 19 pp., diagrs. $0.50.

The author's purpose is to provide a working text for model builders. Lists of equipment and materials are provided, and step-by-step procedures for making a black-powder fuse, tube rolling, making a model rocket plane, small black-powder rockets, yellow smoke flares, small zinc-dust rockets, and a guide-line model rocket unit are given.

Speed Control Line Models. R. H. Warring. London, Percival Marshall & Company, Ltd., 1949. 207 pp., illus., diagrs. 10*s*. 6*d*.

Control-line models hold records of over 163 m.p.h. for reciprocating engines and over 179 m.p.h. for jet engines. This book deals with the design and construction of these models and covers aerodynamic design, air-frame construction, landing gears, performance, engines, propellers, fuel tanks, and operation and flying of the models. Speed tables and tables of design data on leading models are included.

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REFERENCE LITERATURE

DICTIONARIES

Concise International Dictionary of Mechanics and Geology: English, French, German and Spanish. S. A. Cooper. London, Cassell and Company, Ltd., 1949. 400 pp. 12*s*. 6*d*.

About 6,000 English terms, based mainly on general machine parts and mechanical terms, are listed alphabetically with their equivalents in French, German, and Spanish. Indexes of French, German, and Spanish terms are included. Names of varieties of coal, iron, steel, alloys and minerals, geological expressions, chemical reagents, metallurgical terms, mathematical terms, units of measurement, numerals, tools, drawing instruments, wood, timber trees, and automobile parts are included. This is a convenient and well-executed dictionary, which should be most useful.

HISTORY

Coral Sea, Midway and Submarine Actions, May 1942–August 1942. (History of United States Naval Operations in World War II, Vol. IV.) Samuel Eliot Morison. Boston, Little, Brown and Company, 1949. 307 pp., illus., maps $6.00.

The first two thirds of this volume deal with the first great carrier actions of the war in the Pacific, with the Battle of the Coral Sea in May, 1942, and with the decisive Battle of Midway in June, 1942. The Midway account makes use of Japanese as well as American sources. The submarine actions of the first year of the war, including the Makin Raid in August, 1942, decisions in Washington leading to the first strategic offensive actions, and the landings at Guadalcanal and Tulagiside are taken up in the final sections.

General Kenney Reports, A Personal History of the Pacific War. George C. Kenney. New York, Duell, Sloan and Pearce, 1949. 594 pp., maps. $4.50.

General Kenney assumed command of the Allied Air Forces in the Southwest Pacific in August, 1942. This book covers the next three years up to the Japanese surrender, based on the author's diary kept during that time. The result has the salt and authority to be expected and has permanent value as strategic and tactical history, besides being readable. It contains portraits of numerous pilots and their commanders, persons as diverse as General MacArthur and Admiral Halsey, and Major Bong and Colonel Lindbergh, who increased the range of the P-38 from 400 to 600 miles by personal demonstration

YEARBOOKS

Australian Aviation Annual, 1949. Edited by Stanley Brogden. P.O. Box 34, Hawthorne E. 2, Victoria, Australia, The Author, 1949. 192 pp. $1.00.

This combined directory and review of Australian aviation covers scheduled and nonscheduled air lines, fuel suppliers, air craft and equipment manufacturing, Australian representatives of overseas aircraft manufacturers, aviation magazines, aviation organizations, government departments, aeronautical research, and statistics of registered air-craft, air-line operations, and accidents. Besides directory information, including the principal personnel, the functions and the activities of companies and organizations during 1948 are discussed. The book is well done and is the best available reference on Australian aviation.

SCIENCES, GENERAL

Refresher Notes: Hydraulics, Thermodynamics, Machine Design, for Professional Engineers License Examination. John D. Constance. Revised Edition. Cliffside Park, N.J.,

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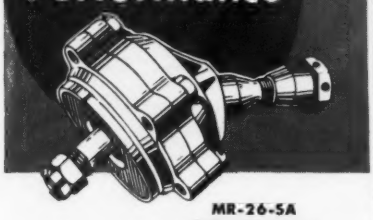

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625 Hudson Terrace, The Author, 1949. 183 pp., diagrs. $4.50.

This book offers a convenient review course for graduate engineers, companies, and engineering colleges, and has applications in preparation for the professional engineers' license examination, refresher courses under company sponsorship, and in study for the Engineers-in-Training Certificate by the young engineering graduate. The hydraulics section includes hydrodynamics, circular orifices, sharp-crested weirs, flow through pipes, flow in open channels, and the centrifugal pump. The thermodynamics section includes the behavior of gases and vapors, processes of gases and vapors, compression and expansion of air, liquids and vapors, flow of gases through orifices and nozzles, fuels and combustion, vapor cycles, steam engines and turbines, internal combustion engines, flow of heat, and refrigeration. The machine design section covers topics in applied mechanics and kinematics of machinery, springs, belt transmission, toothed gearings, lubrication, bearings, flywheels, and forces on crankshafts.

GEOGRAPHY

Economic Geography of the USSR. Edited by S. S. Balzak, V. F. Vasyutin, and Ya. G. Feigin. Translated from the Russian by Robert M. Hankin and Olga Adler Titelbaum. New York, The Macmillan Company, 1949. 620 pp., maps. $10.

Originally published in Russia in 1940, this study of Soviet resources, industries, agricultural production, population, and transport is presented under the Russian translation project of the American Council of Learned Societies. This edition is edited by Chauncey D. Harris, Professor of Geography at the University of Chicago. Detailed data are provided by 53 statistical tables and 84 maps, some of which were not in the original Russian edition. Information of more recent date, such as boundary changes, is given in appendixes.

MATHEMATICS

Tables of Generalized Sine- and Cosine-Integral Functions. (Harvard University, Annals of the Computation Laboratory, Vols. 18 and 19). Cambridge, Mass., Harvard University Press, 1949. 2 Vols.; 462, 560 pp. $10 per volume.

The purpose of these volumes is to present as complete a table of certain integrals as can be included in 1,000 pages and to provide tabulations previously done only fragmentarily and inadequately. Six decimals of accuracy are provided, and the scope of the tabulation is designed to cover cases arising in practice, with provision for interpolation to the accuracy required by the applications. Electromagnetics, hydrodynamics the theory of sound, and the theory of elasticity are typical of the fields of application. The computation was done by the automatic sequence controlled calculator, under Navy contract.

Transformation Calculus and Electrical Transients. Stanford Goldman. New York, Prentice-Hall, Inc., 1949. 439 pp., diagrs. $8.35.

The author's aim is to give a comprehensive and systematic treatment of the subject of transients in linear networks by development of the methods of the Laplace transformation and its inverse. Many of the problems treated are similar to those treated by Heaviside's operational calculus but with the emphasis shifted from the operational point of view to the question of transformations between the t axis and the s plane. The author has coined the term "transformation calculus" for the methods developed, which are designed to simplify the study of physical phenomena. The use of the analytic functions of a complex variable, Gamma and error functions, Bessel functions, and solutions in series are among the topics treated. The author is a professor of electrical engineering at Syracuse University.

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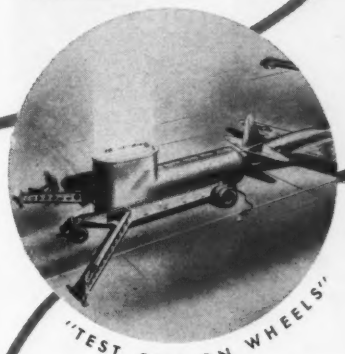

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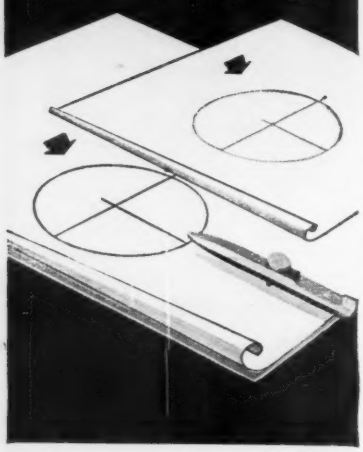

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MECHANICS

Proceedings of the Seventh International Congress for Applied Mechanics, London, 1948. Introduction. Imperial College, South Kensington, London, S.W. 1, H. Levy, 1949. 129 pp.

This introductory volume contains a list of members of the Congress, lists of papers to be published in the remaining volumes, and the following general lectures: Le Tenseur Spectral de la Turbulence Homogène non Isotrope dans un Fluide Incompressible, by J. Kampé de Fériet; Recent Developments in Turbulence Research, by G. K. Batchelor; The Present State of Development of Experimental Stress Analysis, by M. Hetényi; and Recent Developments in the Mathematical Theory of Plasticity, by W. Prager (abstract only).

PHYSICS

Nuclear Radiation Physics. R. E. Lapp and H. L. Andrews. New York, Prentice-Hall, Inc., 1948. 487 pp., illus., diagrs. $6.00.

This textbook was developed from an elementary manual published within the National Military Establishment, first as "Radiological Safety," then as "Radiological Defense." Discussions of natural radioactivity, nuclear radiations of alpha and beta particles and gamma rays, Geiger-Müller counters, radiation-measurement technique, radioactive tracer techniques, and a final chapter on health physics occupy a little over 200 pages and form part of a well-organized interpretation of the phenomena of nuclear physics. The discussion is essentially nonmathematical. Problems accompany each chapter, and tables and other data are included in appendixes. Lists of reference books and articles are included at the ends of chapters. Dr. Lapp is connected with the Research and Development Board, and Dr. Andrews with the National Institute of Health at Bethesda, Maryland.

STRUCTURES

The Elementary Theory of Stressed-Skin Construction. W. S. Hemp. London, Aircraft Engineering, 1949. 31 pp. 2s.

This monograph originally was published in the periodical *Aircraft Engineering*, from May through August, 1949. It is a nonmathematical explanation of the stressing of modern airplane structures, which is designed to give the basic principles for students and the staffs of stress departments in the aircraft industry and to indicate the lines on which detailed calculations may be made. The author is senior lecturer and deputy head of the department of aircraft design at the College of Aeronautics, Cranfield.

Bibliography on X-Ray Stress Analysis, With Subject Index. Herbert R. Isenburger. Califon, N.J., St. John X-Ray Laboratory, 1949. 17 pp. $3.00.

Material on the X-ray method has been included in this list, and a detailed index of about 150 subjects is keyed to the 240 numbered references. Foreign language titles are liberally included and are given in English.

Structural Design in Metals. Clifford D. Williams and Ernest C. Harris. New York, The Ronald Press Company, 1949. 596 pp., illus., diagrs. $6.50.

The aim of the authors is to present a textbook for third-year engineers in the design of structural details, including both riveted and welded details in each phase of work. Complete structures, such as aircraft, buildings, and bridges are felt to be subjects for the later special application of the principles covered. Rivets, bolts, pins, and welding are discussed early in the book, followed by a detailed chapter on the selection of sections, including tension members, beams, and built-up members. A detailed chapter on connections completes the first half of the book. Plate girders, trusses, bearings, light gage structural members, fatigue of structural members, and the rigid frame are discussed in the last half. The authors are heads of the Civil Engineering and Structural Engineering Departments, respectively, at the University of Florida and Fenn College.

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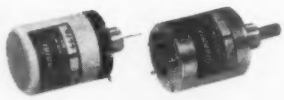

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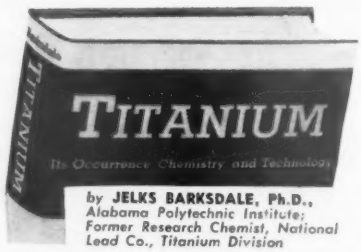

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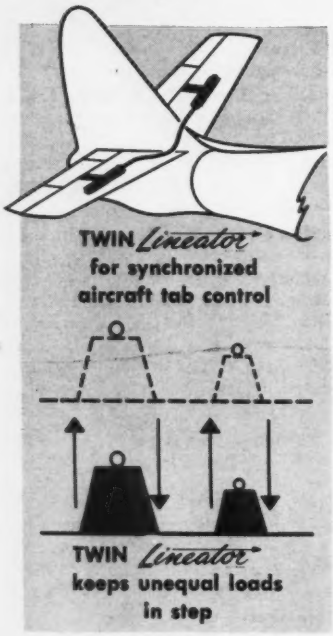

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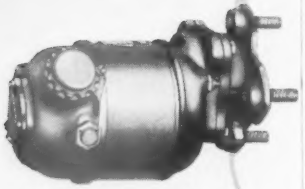

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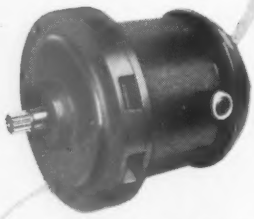

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WANTED

Professor of Aeronautical Engineering—To teach senior and graduate work in aerodynamics, aircraft design, and compressible fluids; conduct research. Administrative and wind-tunnel experience desirable. Degrees: Ph.D., D.Sc., or equivalent. Salary open. Address: Department of Aeronautical Engineering, University of Minnesota, Minneapolis 14, Minn.

Research Engineers—To perform studies on combustion problems; aid in development testing of ram-jet engines. Applicant must have experience in some phase of combustion as applied to ram-jet, turbojet, or pulse-jet engines. Ability to write acceptable reports considered important. **Aerodynamics Engineer**—With advanced degree to perform studies in aerodynamics and thermodynamics. Knowledge of supersonic aerodynamics required. Must have some knowledge of jet-power-plant field, preferably with ram-jet engines. Positions available with progressive young company on West Coast for qualified persons. Salary dependent upon qualifications. Marquardt Aircraft Company, 7801 Hayvenhurst Ave., Van Nuys, Calif.

Engineers—The following vacancies exist at the recently established Naval Aeronautical Rocket Laboratory: Aeronautical Engineers—P-1 through P-6, $2,974.80 through $7,432.20. Electronics Engineers—P-2 through P-4, $3,727.20 through $5,232. Chemists—P-3 through P-5, $4,479.60 through $6,235.20. Chemical Engineers—P-3, $4,479.60. Physicist—P-4, $5,232. Assignments include testing, evaluation, research, and development of liquid-propellant rocket engines. Applicants must have experience and/or training in the construction, operation, and performance of rocket engines. Both staff and project engineer positions are open. Address replies, enclosing completed copy of Civil Service Application Form 57 (obtainable at your Local Post Office), to Donald K. Holster, Personnel Officer, U.S. Naval Aeronautical Rocket Laboratory, Lake Denmark, Dover, N. J.

101. Sales Manager—Experienced sales manager for accessory manufacturer in the Middle West. Excellent opportunity for right man with sales engineering experience. Initiative and ability to sell also of paramount importance. Our employees know of this opportunity. Complete details of experience required.

37. Development Engineer—To make studies of highly technical products and manufacturing operations on a consulting basis. Excellent opportunities for capable engineer experienced in design and development of precision metal equipment. Should possess M.E.—Aero. or Physics degree; graduate work preferred. Require 3 to 5 years' industrial experience and a sound knowledge of production and administrative problems.

30. Aircraft Division Manager—To take charge of Engineering and Sales with a manufacturer of aviation equipment. Must be thoroughly experienced in design and performance of military aircraft and must have wide knowledge of the aircraft industry, as well as the armed forces. Only men with a proved record in the design and marketing of aircraft equipment will be considered.

AVAILABLE

98. Aeronautical Engineer—Bachelor's Degree in mechanical engineering with graduate study in mathematics and aerodynamics. Six years of experience as project engineer in theoretical and wind-tunnel research in the subsonic and transonic speed ranges with specialty in stability and control.

97. Contract Administrator—Administrative Engineer—Graduate engineer with 23 years' experience in the aviation industry, covering aircraft and engine manufacturing and active duty during World War II in the Bureau of Aeronautics. Positions held have included responsible duties in engineering, financial, and administrative work, in most of which there was frequent contact with Government agencies, United States and foreign engineers and technicians. Most recently General Manager of a Research and Development contract coordinating opinions of authorities throughout aviation and allied sciences.

96. Industrial Training Director—Over 20 years' experience directing, supervising, and instructing all types of industrial training programs. Master's Degree in Educational Administration, Bachelor's Degree in Engineering; Licensed Professional Engineer. Experienced in sales, management, and supervisory training programs. Experience largely in aircraft field. Has college teaching experience. Will travel. Immediately available.

95. Technical Assistant to Executive Engineer—Licensed Professional Engineer with advanced degree and with extensive background in the aeronautical industry desires position with prominent aircraft manufacturing or operating organization. C.A.A. licensed commercial pilot for all conventional planes; military and civil instrument rating. Prominent in military programs. Experienced in technical writing. Free to travel.

94. Sales Engineer—Aircraft Accessories—Bach. of Aero. Eng. (N.Y.U.); is also Flight Navigator. Young man with top-notch sales ability seeks connection with manufacturer or manufacturer's representative in aircraft instruments or accessories. Three years' flying experience using all types of aircraft instruments and all navigational aids. Proficient in Pressure-Pattern Flying and Loran systems of navigation. Valuable experience as air-conditioning sales engineer has developed the "feel" of selling an engineered product. Can meet and talk to people with ease. Has proved record of sales ability. Desires position leading to sales engineering. Will undergo training and is ready to travel or relocate. Age 25; single.

93. Aeronautical Engineer—B.S.Ae.E., New York University. One and one-half years' experience with leading aircraft company in various design groups. Desires to obtain a position with company on East Coast. Age 27; single.

92. Management or Administration—Age 30; single. A.B. Degree, University of Pennsylvania. Major in political administration; courses applicable to business administration. Courses in industrial engineering, including industrial relations, business and government, and organization and organizational structure. Aeronautical engineering courses in elementary aerodynamics, performance calculation, aircraft drafting, and engineering. Almost 6 years in aircraft testing in last position. Desires permanent position on junior level in management or administration, with opportunity for advancement. Philadelphia, Pa.

91. Aerodynamicist—B.A.E., New York University. Last 3 years in the guided-missile field. Supervised reduction of flight-test data and analysis. Two years in Navy as supervisor of electronic shop and instructor in radar. Desires position with aircraft manufacturer in flight-test department, doing instrumentation or as flight analyst. Age 27; single.

90. Mechanical Engineer—With M.S. Degree, Stevens Tech., and Professional Engineer's License. Nineteen years' general engineering and business experience, including vibration and noise analysis, development of aircraft engines and accessories, and analysis of supersonic jet power plants. Languages, graduate-level teaching, and lecturing experience in aircraft engines. Desires position requiring general engineering background with experience in related activities.

89. Engineer—Background of 20 years' experience and responsibilities in military aircraft experimental design and development with major aircraft companies and 5 years, most recently, as Senior Project Engineer heading the aircraft armament and turret development section of a leading research organization. Has carried out preliminary studies and development of the structural phases of complete armament systems for the services which incorporated the latest developments in automatic sights, computers, servomechanisms, and radar components. Possesses a thoroughly sound and practical understanding of the shop and manufacturing aspects and the coordination between the engineering groups, shops, sales, and the customer. Age 46, married.

88. Development and Design Engineer—Aero. Engr.; M.S. in M.E. Fifteen years' experience in preliminary design of all types of aircraft, and development work on aircraft components and test equipment. Thorough knowledge of wind-tunnel testing and design of wind-tunnel models. Excellent training in aerodynamics, with experience in flight testing and stress analysis. Desires position that requires design and/or development work in aircraft, or similar technical position with airlines or related industry. Age 47; married. Location—East Coast preferred. Further particulars and references on request.

85. Engineer—Graduate engineer with over 19 years' experience in design, research, and manufacturing, over 12 years of which were in organizing and administering a division of engineering of a well-known aircraft company. Desires a position of responsibility with a progressive company that has good prospects for future advancement.

84. Aeronautical Engineer—Pilot—B.S.Aero.-E., 1948. One year of experience as test engineer with aircraft engines. Naval pilot for 4 years; commercial pilot with multiengine sea and single-engine land ratings. Age 26; single; location open, foreign or domestic.

83. Aeronautical Engineer—Pilot—B. of Ae., Rensselaer Polytechnic Institute, 1949. Three months' experience in structures of pilotless aircraft. Licensed lightplane pilot. Typist. Age 22. Single. Willing to do teaching, research, or

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production engineering in any part of the U.S. Also willing to travel constantly. Can furnish excellent character references.

82. Research Specialist—Experience with outstanding Government and private research organizations. Experimental research in incompressible and compressible aerodynamics. Broad background in wind-tunnel problems: subsonic—5 years, asst. supervisor; supersonic—3 years. Analysis and measurements in fluid dynamics, turbulence, and boundary layer. Research engineer; planned research program. M.S. in Physics; some teaching.

79. Technical Assistant to Executive Engineer—Engineer with extensive background of experience in the aircraft industry and technical training with well-known authority in the aeronautical field desires position in checking, appraising, and formulating research and/or development programs and rendering general technical assistance. Experience includes writing proposals for research and development projects and handling government contracts.

78. Aeronautical Engineer—Pilot—B.S. in Aero. E., Univ. of Ill. One and one-half years experience as a research engineer conducting wind-tunnel research projects. Single-engine commercial and flight-instructor ratings. Currently flying F-47's in the National Guard. Desires position in aerodynamics or flight test, where flight training, experience, and education will be of benefit. Location open.

77. Engineer—Young graduate; B.S.Aero. Eng., Aircraft Design Major. Good at technical reports; desires opportunity in aeronautical field in any capacity. Interested in design and research. Good occasion for company seeking aspiring, serious individual willing to assume responsibility. Salary not important; desires trial, experience. Will relocate anywhere.

76. Associate Professor—M.S. in Math (Physics minor); B.S. in M.E. (Structures option); B.S. in Education. Six years' teaching experience in applied mechanics (statics and dynamics), strength of materials, hydraulics, thermodynamics, aircraft stress, and Engineering Physics. Three years with major airplane company in stress analysis unit and in mechanical equipment unit. Desires teaching position in a progressive college or university. Present position satisfactory but must move because of family's health. Prefers Western States, Texas, or Florida. A detailed outline of experience will be sent upon request.

75. Aviation Technician—A.F.R.Ae.S. Three years as liaison engineer in aircraft manufacturing. Five years as engineer officer with international airline. One year as industrial engineer. Desires position with airline or aircraft manufacturer.

74. Flight Test Instrumentation Engineer—Last 4 years' supervising design, manufacture, installation, and maintenance of experimental flight-test instrumentation on jet aircraft. Fifteen years' general aircraft experience on reciprocal, jet, helicopter, guided missiles. Desires connection in related work but will consider field service or sales representative. Married; age 39, free to travel. Available within 10 days.

73. Aeronautical Engineer—B.A.E., New York University. Three years' flight-test and engineering research experience, including 1 year at Wright Field. One year of sales experience, Air Force supply, and procurement experience. Graduate study in Industrial Engineering.

72. Pilot—Aeronautical Engineer—B.S.Aero.-E., Aeronautical University of Chicago. Five years' general design experience; includes 1 year of specialization in guided—missile design research and proposal work as engineering layout draftsman; consultant on two private aircraft research projects; varied experience in building structures design and in architecture. Rated in U.S.A.F. (R.O.C.) as Engineering Design and Development Officer (MOS 7050). Has current multiengined (land) commercial pilot license. Majority of time is in B-25- and P-38-type aircraft. Desires position as instructor in a technical college or permanent position, with avenues for advancement, in missile design research and development program of an established and progressive firm. Prefers Midwest to Western United States or abroad.

71. Graduate Engineer—B.S. in Ae.E. Ten years of supervisory experience in the design, development, and sales contact of aircraft hydraulic systems, jet-engine accessories, lubrication problems, control and mechanisms, and landing gears.

69. Washington Representative—Aeronautical Engineer, M.S., Ae.E., California Institute of Technology; 18 years' experience in the Naval Aeronautical Organization. Technical operation and administrative, including 2½ years in the Bureau of Aeronautics and over 3 years in the Office of Chief of Naval Operations. Familiar with Government contract procedures, specifications, and requirements. Retired in 1947, with senior naval rank, at age of 45, and living in Washington, D.C., area. Has office to handle Washington representation for reliable company in the aviation industry.

68. Aeronautical Engineer—B.S. in A.E., December, 1948. Experience as stress analyst since graduation. Five years with Air Force as mechanic, navigator, and radar observer. Seeking engineering position in New York-New Jersey area, preferably in aircraft, but will consider other fields of engineering. Age 28; single.

67. Management Staff—Aeronautical engineer, graduate of M.I.T., with broad experience in engineering and sales management in aircraft components field. Has held position of project engineer, administrative engineer, and assistant sales manager. Familiar with production, contracting, and accounting control problems. Has excellent contacts among industry and with

Government groups. Age 34; married. Location open.

66. Engineer — Executive — Pilot — Former Chief Engineer, world's largest manufacturer of propellers for personal aircraft Extensive experience in propeller and fan development on wood and metal, fixed- and variable-pitch propellers and wind-tunnel fans. Broad acquaintances in personal aircraft industry. Flight-test experience on a wide variety of aircraft in functional and performance testing. Patent experience. Commercial Pilot. Unmarried and able to travel anywhere. Age 32.

65. Aircraft Propulsion Engineer—Graduate in Mechanical Engineering from a University in India, with the Postgraduate Diploma of the Indian Institute of Science in Aeronautical Engineering and the Postgraduate Diploma of the Imperial College of Science and Technology, London, England. Desires a position with an air line or an aero-engine manufacturer as a testing or field service engineer or in any other suitable technical capacity. Has the following experience and background to offer: More than 2 years of general engineering and business experience, including responsible positions. In addition, 1 year of experience in India and England in aeronautics as an employee of a Czechoslovakian engine manufacturer in Prague. Fluent command of the Czech language and an elementary knowledge of Spanish. Extensive top-level contacts in Indian and Czech civil aviation and industry. Age 26; bachelor; willing to work on contract or permanent basis. Interesting work the main consideration. Further particulars and references on request.

64. Aeronautical Engineer Stress Analyst—M.Sc. (Math.), B.Sc. (Physics, Chem., Math.). Four years' teaching experience. Devoted 8 years to design, development, and research work on aero engines and propellers. Some experience in aircraft work. Desires position that requires design and/or research on problems in structures, aero engines, or allied mathematical subjects, including statistics either in aircraft industry or an aeronautical institution. Age 37. Resident of England and English citizen.

63. Aerodynamicist—B.S. Some graduate work. Age 27. Stability and control, wind tunnel work, special devices. Five years' experience in aircraft industry.

62. Aviation Maintenance Engineer—B.S. Aero. Eng. C.A.A. aircraft and engine mechanic, restricted radio operators permit. Three years' experience in the business and maintenance of various transports. Desires position that will use abilities with air line, operator, feed line, maintenance shop, etc. Age 23; married; available immediately.

61. Aeronautical Engineer—1949 graduate. Five years' experience in airplane and engine maintenance, manufacturing, and modification. Underwent pilot training in Army. Age 25, ambitious, desires permanent position with opportunity for advancement in Production Manager's Department of aviation or related industry. Available immediately.

60. Engineering Pilot—B.S. Aero. E., University of Michigan. Age 31; married. Fourteen years' flying experience. Pilot—commercial airplane single- and multiengined land, with instrument and flight instructor ratings; 2,600 hours' total flying time, 1,700 multiengined. Three and one-half years' flight-test experience with West Coast manufacturer as engineering test pilot. Has thorough engineering and flight background in aircraft performance, stability, and controllability, with broad experience in aircraft engine design and performance. Three and one-half years with air lines as air-line pilot, engineering and maintenance test pilot, and consulting engineering pilot. Experienced in domestic and overseas air-line piloting. Has thorough working background in flight analysis work with emphasis on aircraft performance as applied to the C.A.A. requirements for Air Transport Category, including considerable experience in airport analysis work. Has engaged in, and been in charge of, development of Pilots Aircraft Operating Manuals for aircraft manufacturer and air lines, and development of flight-test procedure manuals for air-line test pilots. Interested in engineering and piloting position with air line or manufacturer offering possibilities of good future.

59. Aeronautical Engineer—Twelve years' successful commercial, technical, and administrative experience, including power-plant development and air transport. International contacts. Location open.

57. Aeronautical Executive—Washington, D.C. Retired Officer (1st Lt., U.S.M.C.); 18 years' experience in operation and maintenance of naval and military aircraft, desires full- or part-time position contacting Latin American Air Attachés. Several years' experience in Latin America. Fluent Spanish. Had complete charge of maintenance of several hundred aircraft during World War II. Would consider full-time Latin American assignment or assistant to air-line executive.

56. Aeronautical Engineer—Design, Stress, or Research—Doctor's Degree. Ten years' industrial experience in responsible design and research capacity. Presently head of aeronautical option with eastern college. Would consider with interest an outside position for a design, research, and/or development assignment in structures or general air-frame design field. Could dedicate up to 200 engineering man-hours per week by utilizing other faculty members with equivalent industrial experience.

55. Associate Professor—Aeronautical or Mechanical Department. Doctor's Degree. Ten years' industrial experience in supervisory design capacity. Teaching experience in stress analysis, aircraft structures, theory of machines, thermodynamics, fluid mechanics, etc. Wants similar position with university in New York Metropolitan Area or vicinity.

54. Industrial Engineer—Experienced in cost reduction, time study, methods, production control, plant layout, and related work. Background includes 3 years' aircraft manufacturing experience. B.S., M.S.

52. Air Transportation—Purdue University Graduate, June, 1949. B.S. degree in Air Transportation. Desires position in aviation sales, service, management, or maintenance. Age 24. Will locate anywhere. Four years' retail sales experience. Has private pilot's license, A & E License, Ground Instructor in A & E license. Business administration and technical educational background. Twenty-six months U.S. Air Force. Complete résumé upon request.

Members Elected

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Thomas, John W., M.S. & Ae.E., Aerodynamicist, Douglas Aircraft Co., Inc. (Santa Monica).

Thue, K. S., B.A.Sc., Aero. Engineer, Aerodynamics Section, Gas Turbine Div., A. V. Roe Canada Ltd. (Toronto).

Titus, Paul V., B.S., Mathematician, Aerodynamics Group, North American Aviation, Inc.

Tursich, Ernest J., B.S. in Ae.E., Instructor in Engineering, Iowa State College.

Van Pelt, Clinton, A.E., Liaison Engineer, Chance Vought Aircraft Div., United Aircraft Corp.

Varga, LeRoy M., B.S. in Ae.E.

Vidal, Robert J., B.S., Jr. Aerodynamicist, NEPA Div., Fairchild Engine & Airplane Corp.

Wetz, William H., B.S. (Aero.), Engineer, Beech Aircraft Corp.

Wiard, William D., B.S. in Ae.E., Aero. Research, Design & Development Engineer P-1, Air Materiel Command, Wright-Patterson Air Force Base.

Wilhoff, Fred J.

Wirth, Charles J., B.M.E.

Woodard, Claude R., B. of M.E. (Aero), Graduate Student, Syracuse University.

Wykes, John H., A.E., Mathematician, Aerodynamics Group, North American Aviation, Inc.

Yates, E. Carson, Jr., M. of Engineer, ing Math., Aero. Research Scientist-N.A.C.A., Langley Air Force Base.

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Eighteenth Annual Meeting

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Some Aspects of Turbojet Combustion

(*Continued from page 26*)

Factors Affecting Progress in Combustor Development

Without much doubt, the progress in some phases of turbojet combustion has been exceedingly rapid, and it is interesting to speculate as to the favorable factors responsible for this. Chief among these are:

(1) The simple cylindrical type of combustor can be isolated completely from the compressor and turbine for test and development purposes.

(2) Fortunately, the General-Electric type of combustor is built and altered so readily that numerous cut-and-try refinements may be made in a short interval of time.

With some care in duplicating the actual engine conditions of air supply to the combustor, it has been demonstrated frequently that test results on single combustors are quite representative of actual combustor performance on the engine. The conditions of entering air flow are never sufficiently uniform in any type of turbojet, and, thus far, it has proved expedient to accept the nonuniformity of air supply from the compressor and to correct it by the combustor design rather than to attempt to correct the air flow in the compressor. Thus, unlike the combustion process in the piston engine, or even in the steam boiler, development could be carried out in parallel with other developments, and conditions could be varied over and beyond any possibilities in an integrated system. Furthermore, test instrumentation is simplified, and observations are more intimate where the combustor can be so segregated from the power plant.

Conclusion

In conclusion, this paper has attempted to portray the gas-turbine combustor as a three-dimensional flaming carburetor with widely varying volume and pressure. To this may be added the extreme variations in initial temperature of the air. Considering the complexities described, the relatively high performance attained seems gratifying.

The principal challenge for the future appears to lie in the low-pressure range rather than from any increase in area- or space-rates of combustion. Rather than tending to discount the likelihood of making substantial improvements, this paper has presented turbojet combustion as an extremely complex problem that will justify continued refinements in old configurations as well as "prospecting" for new types.

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